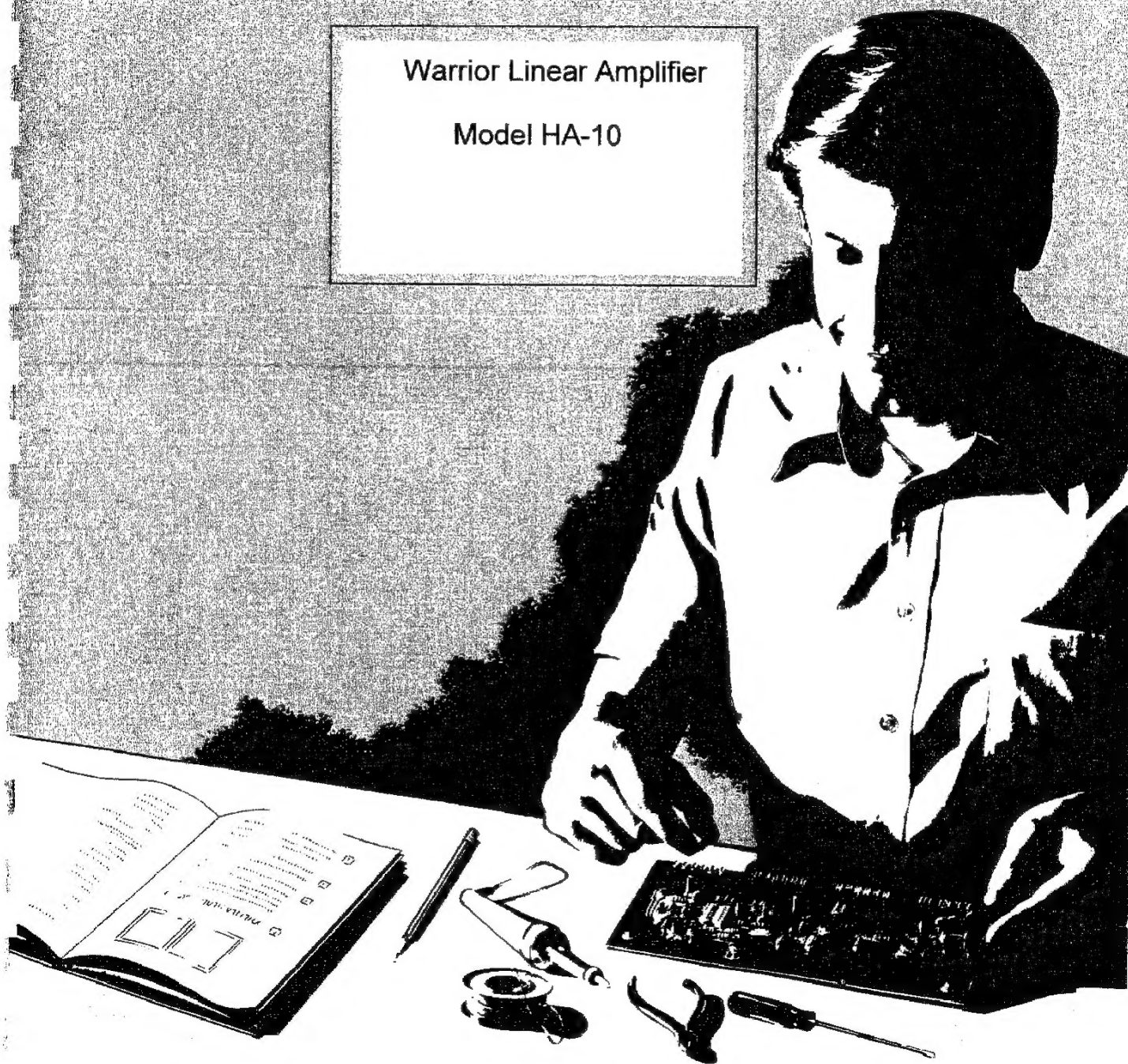


# HEATHKIT<sup>®</sup> MANUAL

Warrior Linear Amplifier

Model HA-10

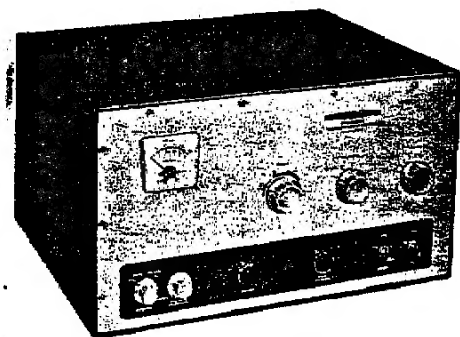


HEATH COMPANY • BENTON HARBOR, MICHIGAN

# Assembly and Operation of the



## "WARRIOR" LINEAR AMPLIFIER MODEL HA-10



HEATH COMPANY,  
BENTON HARBOR,  
MICHIGAN

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6/19/64

## SPECIFICATIONS

Driving Power Required: . . . . .	50 to 75 watts, depending on frequency.
Maximum Power Input: . . . . .	SSB - 1000 watts P.E.P. CW - 1000 watts. AM - 400 watts (500 watts using controlled carrier modulation). RTTY- 650 watts.
Output Impedance: . . . . .	50 to 75 ohms variable pi network output circuit.
Input Impedance: . . . . .	Approximately 70 ohms. Broadband input circuit requires no tuning.
Band Coverage: . . . . .	80, 40, 20, 15, 10 meters.
Panel Metering: . . . . .	0-200 ma grid current. 0-1000 ma plate current. 0-2000 volt plate voltage. 0-1000 relative power.
Panel Controls: . . . . .	Band Switch                      Tuning Meter Switch                    Loading Relative Power Sensitivity    Power-On-Off High Voltage-On-Off
Tube Complement: . . . . .	4 - 811A                      2 - 866A
Power Supply: . . . . .	Filament, bias, 1500 V DC plate supply, and blower - self-contained.
Power Requirements: . . . . .	1250 watts maximum, 117 volts, 50/60 cycles.
Cabinet Size: . . . . .	19-1/2" wide x 11-5/8" high x 16" deep.
Net Weight: . . . . .	90 lbs.
Shipping Weight: . . . . .	100 lbs.

## INTRODUCTION

With the increasing popularity of single-sideband, suppressed-carrier phone transmission as a mode of amateur communication, more amateurs are finding it possible to run higher transmitter power inputs than they could previously afford with conventional AM equipment. Since high-level modulating equipment is not necessary in single-sideband service, the cost of converting to high power is considerably reduced.

In keeping with this trend toward higher power in single-sideband service, the HEATHKIT "Warrior," Model HA-10 Linear Amplifier was

designed to provide high power capability and complete versatility. Nearly any of the popular SSB, CW, and AM exciters available today can be used as a driver for this amplifier.

The amplifier RF compartment is completely enclosed by perforated steel shielding. This type of construction increases amplifier stability and greatly decreases radiations that could cause TVL. The amplifier is forced-air cooled to promote longer tube life.

Unique built-in circuitry provides a constant RF sampling output to a monitoring scope, regardless of frequency.

## CIRCUIT DESCRIPTION

### HIGH-VOLTAGE POWER SUPPLY

The high-voltage supply consists of the plate transformer, full-wave 866A rectifiers, swinging choke input filter, oil-filled capacitor, and a 60 K $\Omega$  bleeder resistor.

Frequently, well designed power supplies using conventional values of electrolytic capacitors in the filter network have been found to make violent voltage excursions as loads are suddenly applied or removed. These voltage excursions are known as the dynamic regulation characteristics of the power supply. In a linear amplifier, poor dynamic regulation results in lower peak power output and increased distortion products. To assure good dynamic regulation, this power supply incorporates an 8  $\mu$ fd oil-filled capacitor and a filter choke that "swings" between 50 and 5 henrys, from no load to full load. This type of choke is used to keep the filter inductance near the critical value for all load conditions.

In order to remove the high DC voltage from the swinging choke, the choke is connected between the plate transformer center tap and chassis ground.

### INPUT CIRCUIT

The four 811A tubes are connected in parallel in a cathode driven, or grounded grid, Class B configuration. Driving power is coupled to the filament circuit of the 811A tubes through two .01  $\mu$ fd ceramic capacitors. To keep the filament-transformer capacity from shunting the RF driving voltage to ground, the filament transformer is isolated from the input circuit by a broadband filament choke. The plate current return for the 811A tubes is provided by the transformer center tap to ground.

In a grounded grid amplifier, positive feedback is from plate to cathode through the plate-cathode, or plate-filament, capacitance of the tube. A neutralizing coil is wound on the filament choke and is polarized for negative feedback. The voltage fed back through the neutralizing coil balances the voltage fed back through the plate-filament capacitance.

### OUTPUT CIRCUIT

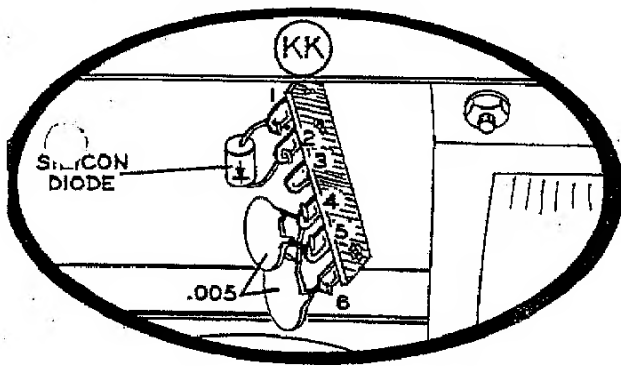
The output circuit uses a conventional pi network for maximum harmonic suppression and ease of tuning. The plates of the 811A tubes are shunt fed, using an appropriate RF choke, blocking capacitor, bypass capacitor, and parasitic chokes. The tuning capacitor on the input side of the tapped inductor is a 350  $\mu$ mf variable, rated at 2 kv. The loading capacitor on the output of the tapped inductor is a 2-gang variable with a total capacitance of 874  $\mu$ mf, rated at 1 kv. A fixed 500  $\mu$ mf, 2 kv mica capacitor is switched in parallel with the 2-gang variable on 40 meters. Another 500  $\mu$ mf, 2 kv mica capacitor is switched in parallel on 80 meters, making a total of 1874  $\mu$ mf.

### BIAS SUPPLY

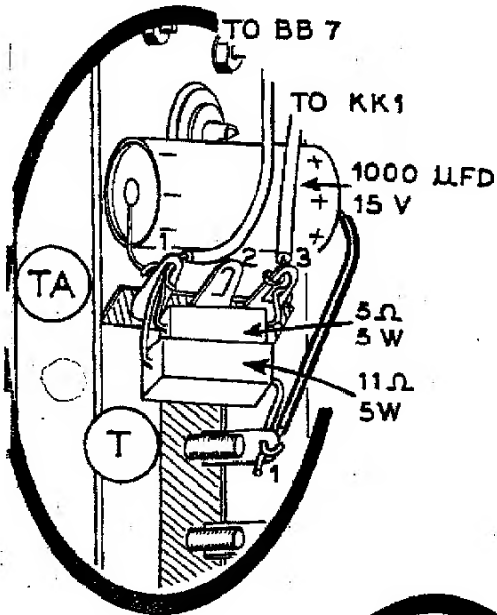
The bias supply of a class B linear amplifier should be quite "stiff," because any changes in bias voltage, caused by the large amounts of grid current drawn by the amplifier, would result in non-linearity. The built-in bias supply consists of the bias winding on the filament transformer, a silicon rectifier, a 5  $\Omega$  surge resistor, a 1000  $\mu$ fd electrolytic filter capacitor, and the 11  $\Omega$  bleeder resistor. The 4.5 volts developed result in a bleeder current of slightly over 400 ma. This large amount of bleeder current, together with the high-capacity filter capacitor, results in a bias supply that is quite "stiff."

### CONTROL CIRCUIT

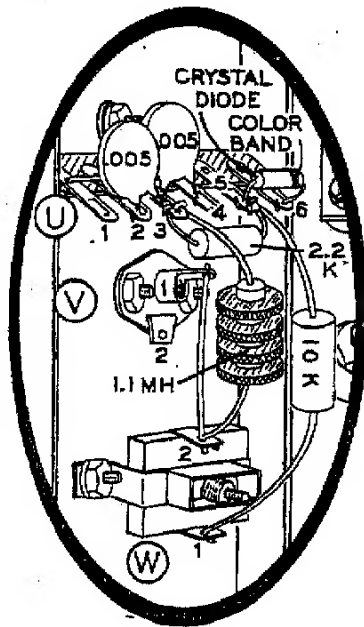
A notable design feature is the protective switching arrangement for the POWER and HIGH VOLTAGE switches. Since the rectifier tubes require a warmup period before high voltage is applied, the POWER and HIGH VOLTAGE switches are connected so that both must be turned ON to apply high voltage, and both switches must be turned OFF to turn the filament circuits off. This feature prevents the possibility of turning the amplifier off with the POWER switch alone while leaving the HIGH VOLTAGE switch in the ON position and thus setting up a condition where high voltage AC would be applied to the rectifiers when the POWER switch was again turned ON.



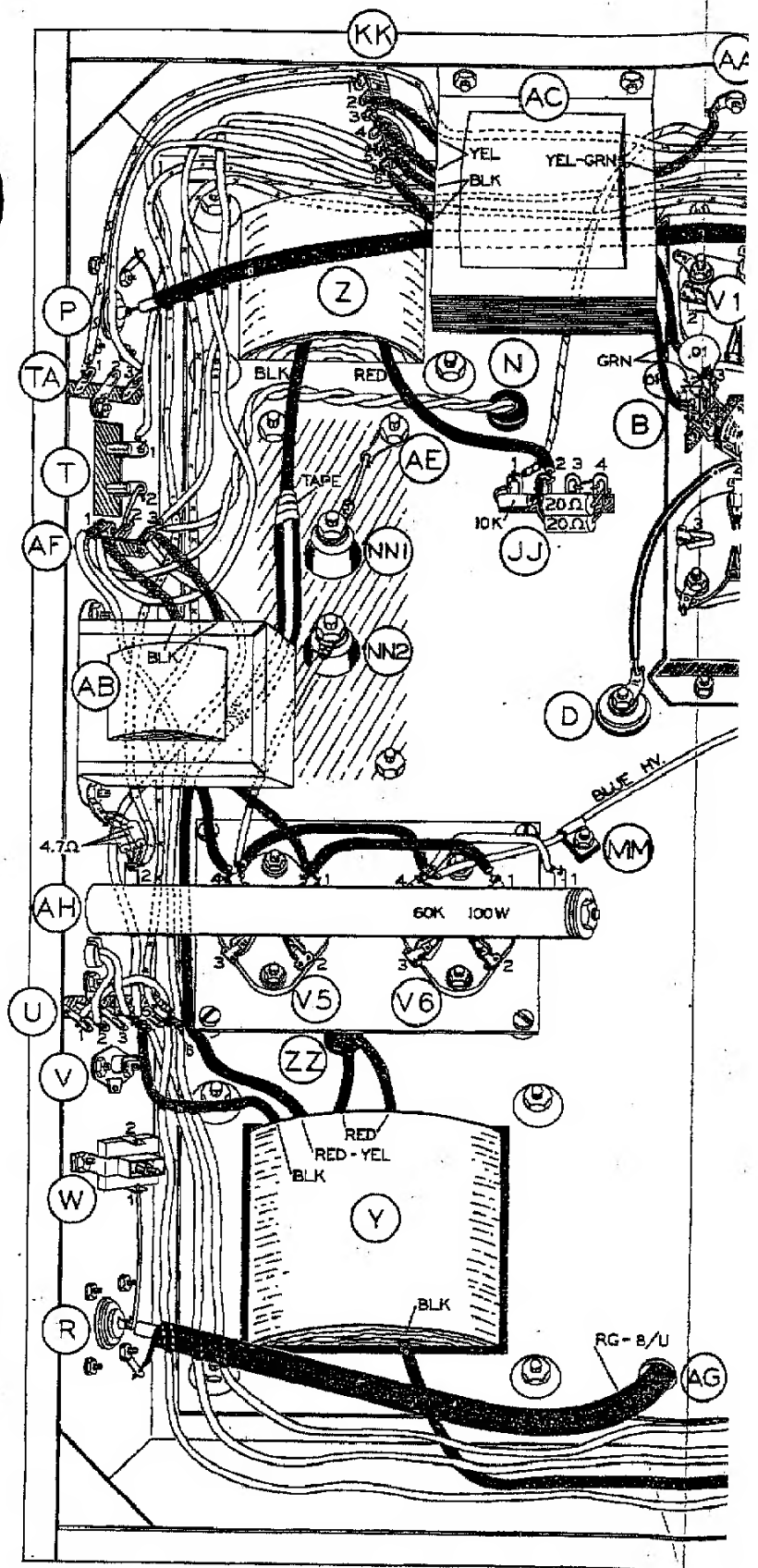
Detail 7G



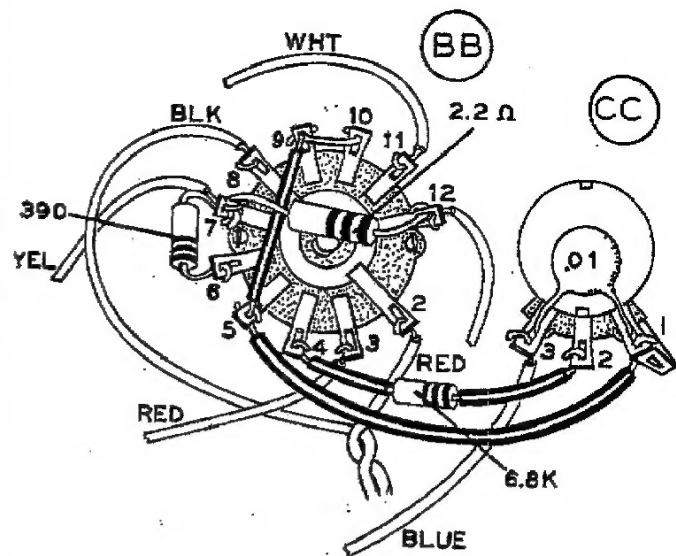
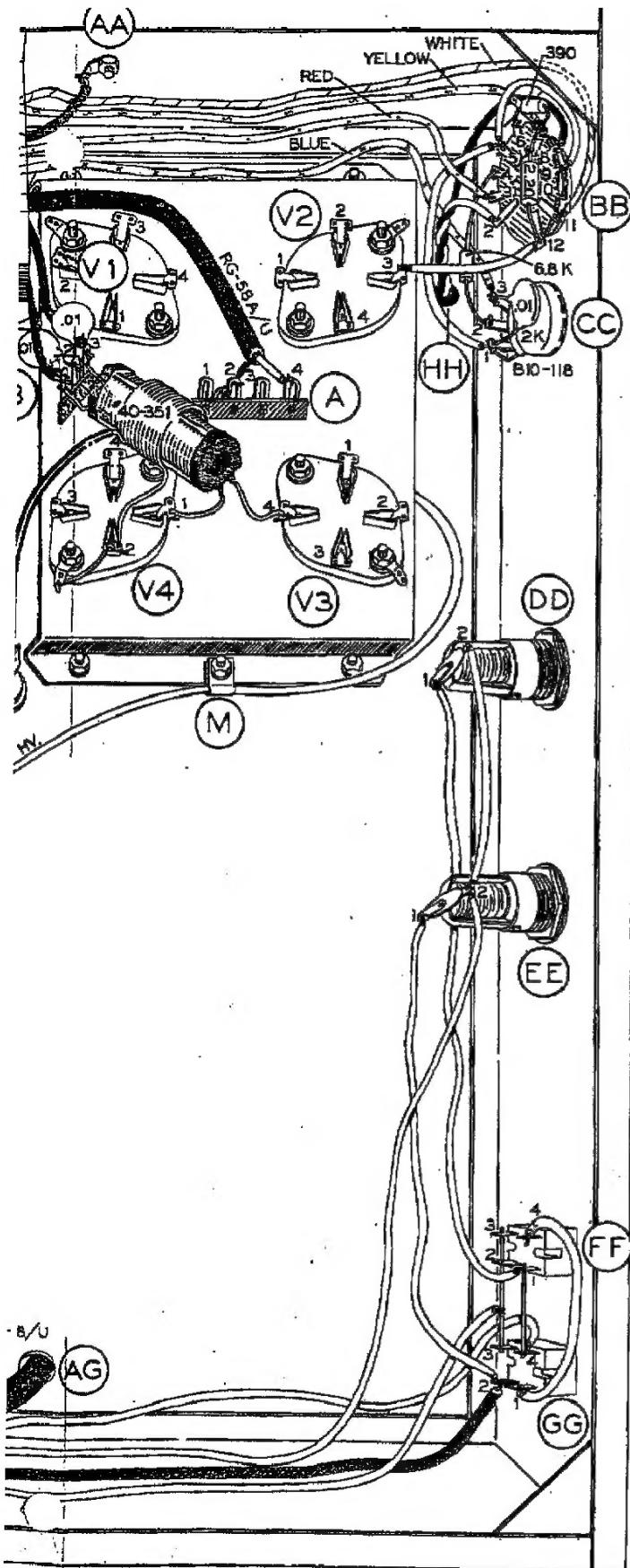
Detail 7J



Detail 7F

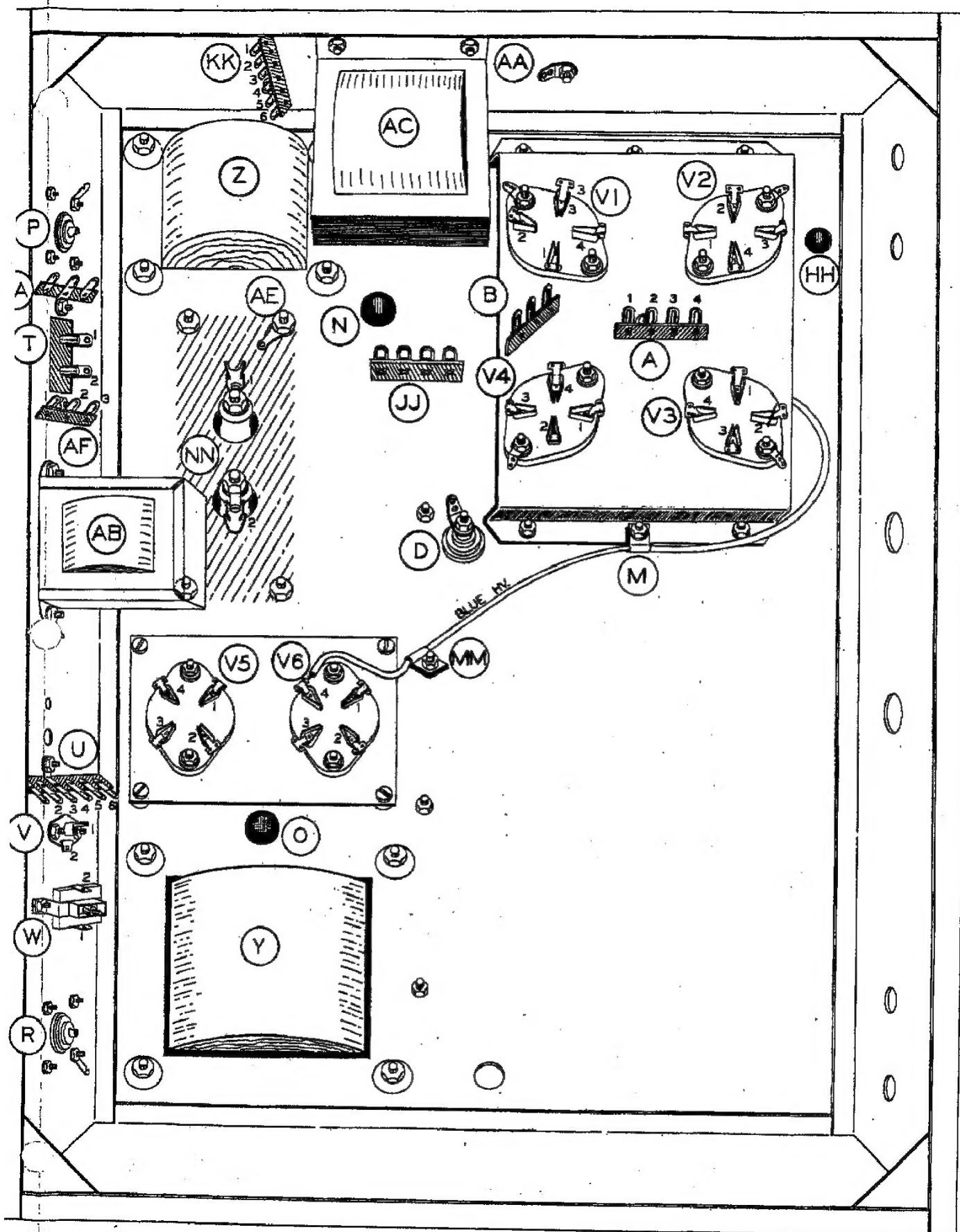


Pictorial 7

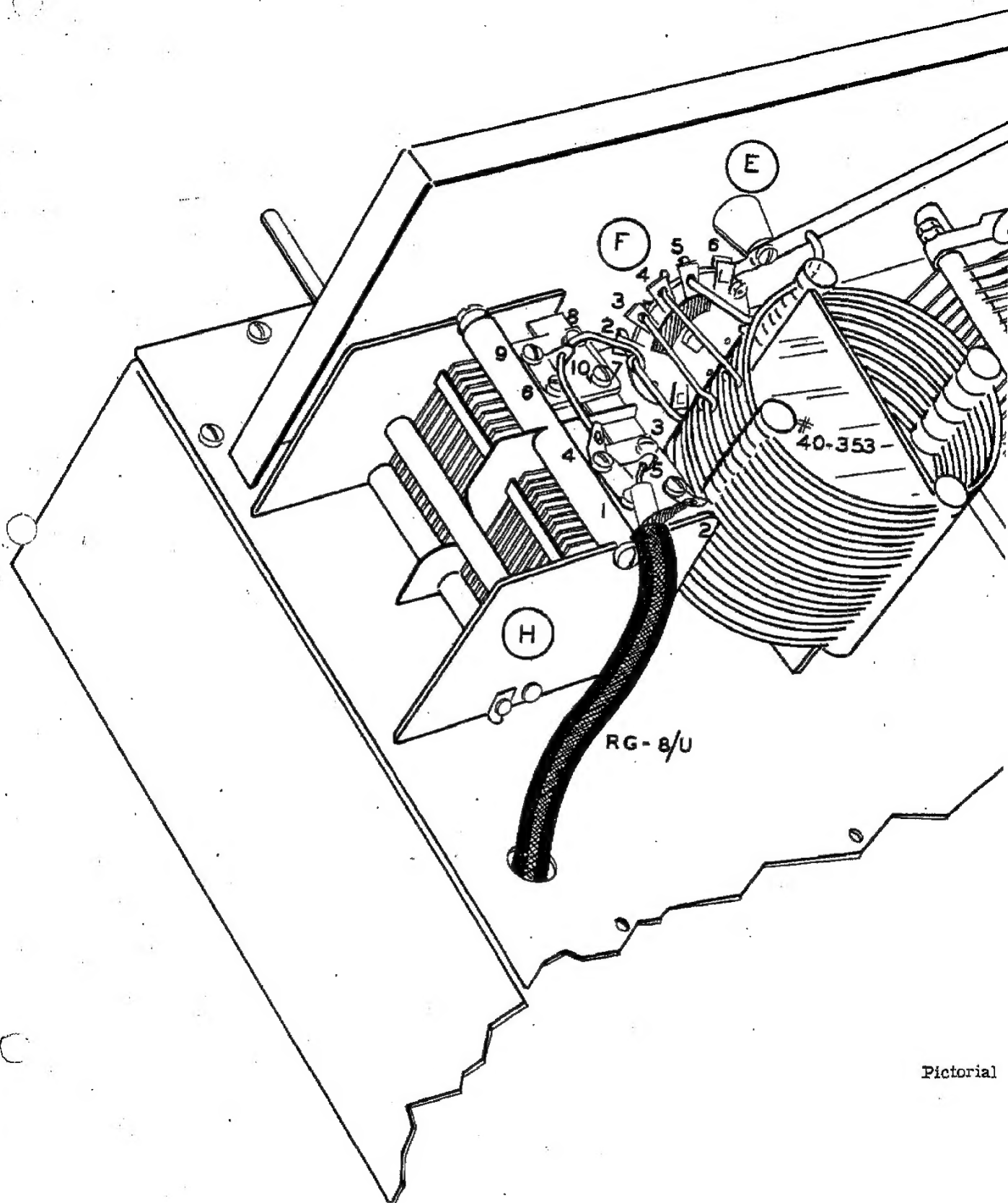


Detail 7H



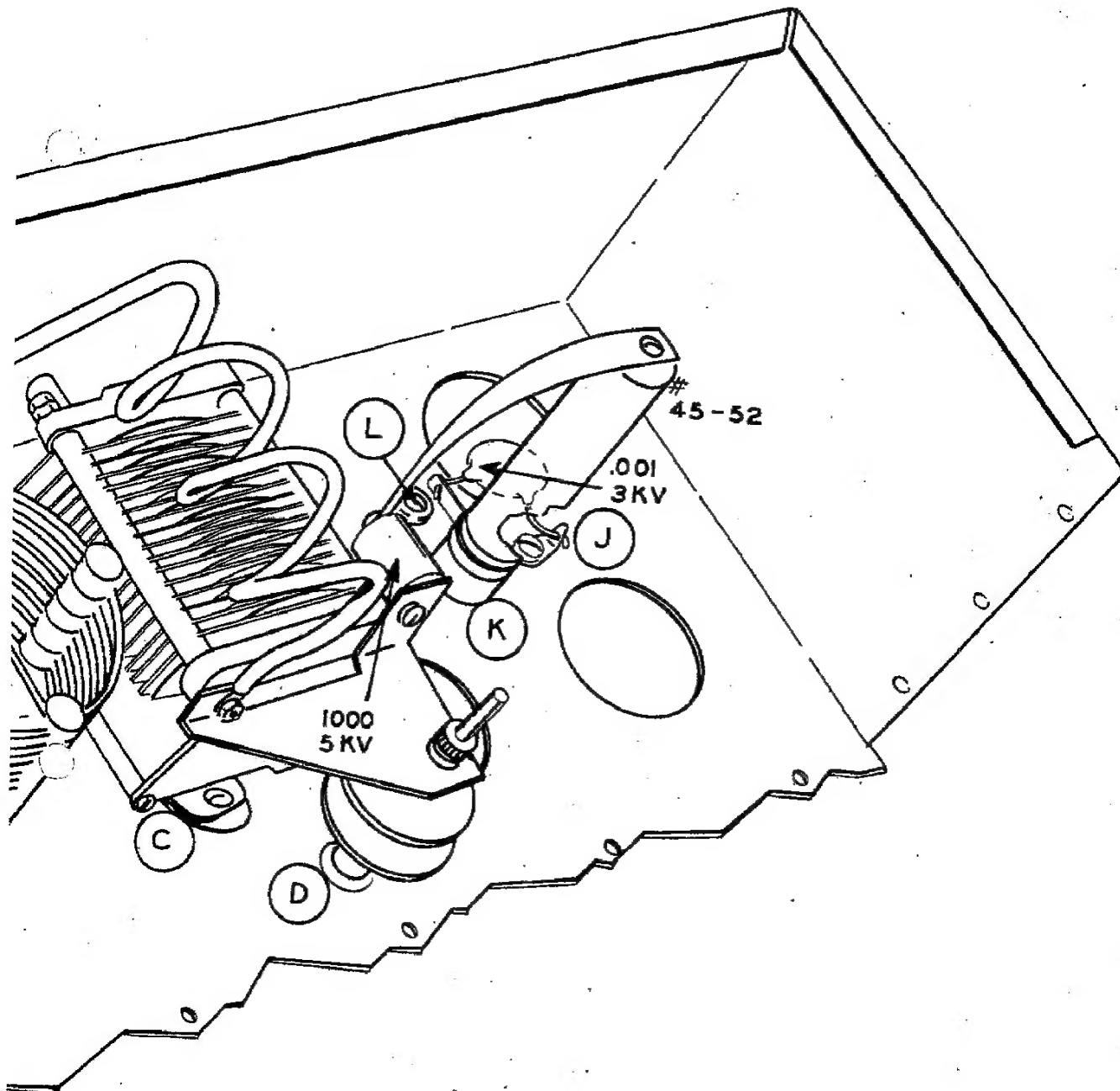


Pictorial 5

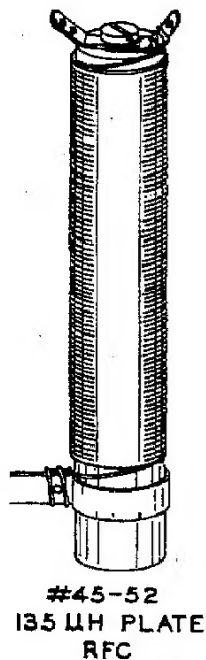
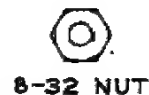
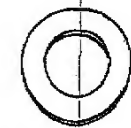
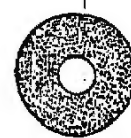
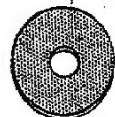
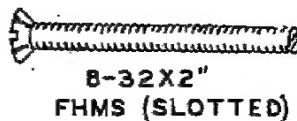
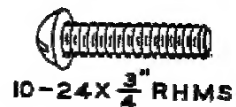
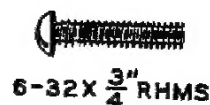
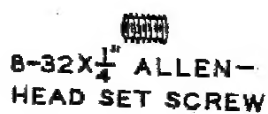
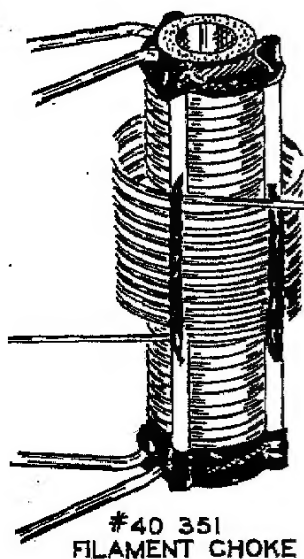


Pictorial



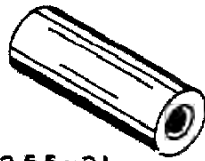


Pictorial 4





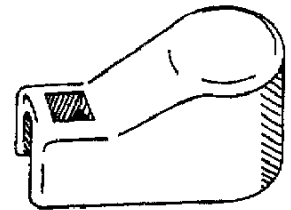
FIBER SHOULDER WASHER



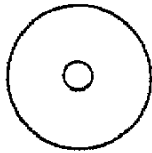
#255-31  
PHENOLIC  
SPACER



#56-4  
CRYSTAL  
DIODE



#260-23  
CERAMIC PLATE CAP



#10 FLAT  
WASHER  $\frac{1}{4}$ " OD



#6 SOLDER  
LUG



#207-3  
CABLE CLAMP



THICK STEEL  
WASHER



#8 SOLDER LUG



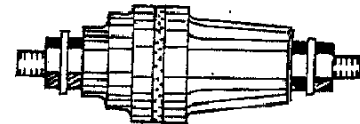
#57-29  
SILICON  
RECTIFIER



#6 LOCKWASHER



#10 SOLDER  
LUG



#71-2  
CERAMIC FEED-  
THROUGH INSULATOR



#8 LOCKWASHER

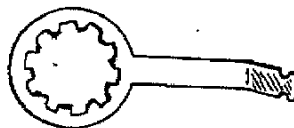


#6 SMALL  
SOLDER LUG

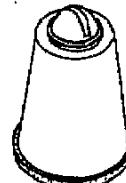
HER



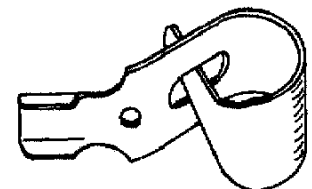
$\frac{3}{8}$ " CONTROL  
LOCKWASHER



CONTROL SOLDER  
LUG



#71-4  
STANDOFF  
INSULATOR



#260-34  
PLATE CLIP

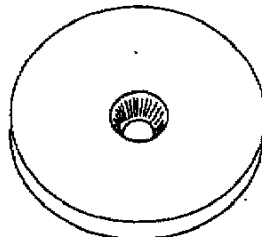
OD



#10 LOCKWASHER



#3 LOCKWASHER



#205-M275  
NEUTRALIZING  
CAPACITOR PLATE



#75-30  
LINE CORD  
STRAIN RELIEF



$\frac{1}{4}$ " #455-31  
BUSHING



#12 LOCKWASHER

## CONSTRUCTION NOTES

This manual is supplied to assist you in every way to complete your kit with the least possible chance for error. The arrangement shown is the result of extensive experimentation and trial. If followed carefully, the result will be a stable instrument, operating at a high degree of dependability. We suggest that you retain the manual in your files for future reference, both in the use of the instrument and for its maintenance.

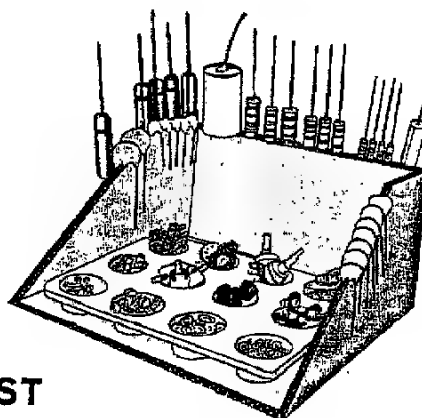
**UNPACK THE KIT CAREFULLY AND CHECK EACH PART AGAINST THE PARTS LIST.** In so doing, you will become acquainted with the parts. Refer to the charts and other information on the inside covers of the manual to help you identify the components. If some shortage or parts damage is found in checking the Parts List, please read the Replacement section and supply the information called for therein. Include all inspection slips in your letter to us.

Resistors generally have a tolerance rating of 10% unless otherwise stated in the Parts List. Tolerances on capacitors are generally even greater. Limits of +100% and -20% are common for electrolytic capacitors.

We suggest that you do the following before work is started:

1. Lay out all parts so that they are readily available.
2. Provide yourself with good quality tools. Basic tool requirements consist of a screwdriver with a 1/4" blade; a small screwdriver with a 1/8" blade; long-nose pliers; wire cutters, preferably separate diagonal cutters; a pen knife or a tool for stripping insulation from wires; a soldering iron (or gun) and rosin core solder. A set of nut drivers and a nut starter, while not necessary, will aid extensively in construction of the kit.

Most kit builders find it helpful to separate the various parts into convenient categories. Muffin tins or molded egg cartons make convenient trays for small parts. Resistors and capacitors may be placed with their lead ends inserted in the edge of a piece of corrugated cardboard until they are needed. Values can be written on the cardboard next to each component. The illustration shows one method that may be used.



## PARTS LIST

PART No.	PARTS Per Kit	DESCRIPTION
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### Resistors

1-19	1	6.8 K $\Omega$ 1/2 watt (blue-gray-red)
1-20	1	10 K $\Omega$ 1/2 watt (brown-black-orange)
1-48	1	390 $\Omega$ 1/2 watt (orange-white-brown)
1-129	3	4.7 $\Omega$ 1/2 watt (yellow-violet-gold)
1A-23	1	2.2 K $\Omega$ 1 watt (red-red-red)
1B-3	1	10 K $\Omega$ 2 watt (brown-black-orange)
3B-5	1	2.2 $\Omega$ 2 watt (red-red-gold)
1B-21	2	20 $\Omega$ 2 watt (red-black-black)
3E-7	1	11 $\Omega$ 5 watt wire-wound
3E-20	1	5 $\Omega$ 5 watt wire-wound
3Y-7	1	60 K $\Omega$ 100 watt wire-wound

### Capacitors

21-16	6	.01 $\mu$ fd disc
21-31	4	.02 $\mu$ fd disc
21-72	4	.005 $\mu$ fd disc 1.4 kv
21-80	1	1000 $\mu$ fd 5 kv tubular ceramic
21-90	1	.001 $\mu$ fd 3 kv disc
21-123	2	500 $\mu$ fd 2000 V silver mica
24-5	1	8 $\mu$ fd 2 kv oil filled
25-78	1	1000 $\mu$ fd 15 V electrolytic
26-25	1	350 $\mu$ fd variable
26-76	1	437 $\mu$ fd per section, 2-gang variable
31-35	1	150 $\mu$ fd compression mica with shaft

PART No.	PARTS Per Kit	DESCRIPTION
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### Coils-Chokes-Transformer

40-351	1	Filament choke
40-352	1	10-meter coil
40-353	1	Multi-band coil
45-4	1	1.1 mh RFC
45-52	1	135 $\mu$ h plate RFC
45-53	4	Parasitic choke
46-28	1	5-50 henry filter choke
54-110	1	Plate transformer
54-111	1	Rectifier filament trans- former
54-112	1	Filament and bias trans- former

### Sockets-Terminal Strips-Knobs

431-6	1	2-lug screw terminal strip
431-10	3	3-lug terminal strip
431-12	1	4-lug terminal strip
431-40	1	4-lug terminal strip
431-45	2	6-lug terminal strip
434-42	1	Phono socket
434-66	1	Pilot lamp socket (green)
434-67	1	Pilot lamp socket (red)
434-96	6	4-pin ceramic socket
436-5	2	Coaxial jack
438-11	1	Fused plug
462-36	1	Small red knob
462-158	3	Large knob
462-129	2	Small skirted knob

### Hardware

250-8	18	#6 sheet metal screw
250-28	1	6-32 x 1/4" slot-head set- screw
250-47	1	8-32 x 2" FHMS (flat head machine screw)

PART No.	PARTS Per Kit	DESCRIPTION	PART No.	PARTS Per Kit	DESCRIPTION
<u>Hardware (Cont'd.)</u>			<u>Controls-Switches</u>		
250-49	8	3-48 x 1/4" PHMS (pan head machine screw)	10-118	1	2 K $\Omega$ control
250-50	10	10-32 x 3/8" PHMS (Phillips head machine screw)	61-3	2	DPST toggle switch
250-51	8	#10 sheet metal screw	63-253	1	Meter switch
250-56	37	6-32 x 1/4" BHMS (binder head machine screw)	63-254	1	Band switch
250-89	44	6-32 x 3/8" BHMS (binder head machine screw)	<u>Meter-Tubes</u>		
250-93	8	8-32 x 1/4" Allen head set-screw	407-78	1	1 ma, 50 $\Omega$ meter
250-126	2	10-32 x 1/2" THMS (truss head machine screw)	411-130	2	866A tube
250-134	12	6-32 x 3/4" RHMS (round head machine screw)	411-151	4	811A tube
250-137	10	8-32 x 3/8" PHMS (pan head machine screw)	412-2	2	3 watt, 120 V lamp
250-152	4	10-24 x 3/4" RHMS (round head machine screw)	421-21	2	15 ampere fuse, 3AB
250-189	1	10-24 x 7-1/2" resistor stud	<u>Metal Parts</u>		
250-190	1	8-32 x 2" FHMS neutralizing capacitor adjust screw	100-M304F432	1	Chassis base
251-1	16	Spade bolt	203-M228F434	1	Front panel
252-1	8	3-48 nut	204-M249	1	Coil mounting bracket
252-3	99	6-32 nut	204-M371	1	Amplifier tube mounting bracket
252-4	15	8-32 nut	204-M373	1	Neutralizing capacitor mounting bracket
252-7	6	3/8" control nut	204-M375	2	Filter capacitor mounting bracket
252-28	1	8-32 thumbnut	205-M271	1	Chassis top plate
252-30	10	10-24 nut	205-M272	1	Rectifier tube mounting plate
252-31	1	10-24 wing nut	205-M273	1	RF shield top plate
252-39	1	1/4 - 32 nut	205-M274F433	1	Escutcheon plate
253-1	24	#6 flat fiber washer	205-M275	2	Neutralizing capacitor plate
253-3	5	#10 flat fiber washer, 1/2" OD	206-M148	1	RF shield, front section
253-6	2	#10 flat fiber washer, 11/16" OD	206-M149	1	RF shield, rear section
253-10	3	3/8" control flat washer	212-M3	1	Silver plated strap
253-16	1	Fiber shoulder washer	<u>Miscellaneous</u>		
253-19	5	#10 flat steel washer, 3/4" OD	56-4	1	Crystal diode
253-27	1	Thick steel washer	57-29	1	Silicon rectifier
254-1	116	#6 lockwasher	71-2	1	Ceramic feed-through insulator
254-2	14	#8 lockwasher	71-4	1	Ceramic standoff insulator
254-3	9	#10 lockwasher	73-1	4	3/8" rubber grommet
254-4	5	3/8" control lockwasher	73-4	2	5/16" rubber grommet
254-7	8	#3 lockwasher	74-4	1	Roll of tape
254-14	1	#12 lockwasher	75-30	1	Line cord strain relief
255-31	4	Phenolic spacer	89-17	1	Line cord
259-1	10	#6 solder lug	90-163	1	Cabinet
259-2	1	#8 solder lug	207-3	2	Cable clamp
259-5	1	#10 solder lug	260-23	2	Ceramic plate cap
259-6	2	#6 small solder lug	260-34	4	Spring type plate clip
259-10	1	3/8" control solder lug	261-6	4	Rubber feet
			266-21	1	Fan blade
			340-1	1	Length #14 bare wire

PART No.	PARTS Per Kit	DESCRIPTION
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## Miscellaneous (Cont'd.)

343-8	1	Length RG-8/U coaxial cable
420-3	1	Motor
453-104	1	Extension shaft
455-10	3	3/8" bushing
455-31	1	1/4" bushing
456-7	1	Shaft coupling
490-6	1	5/64" Allen wrench
331-6		Solder
595-402	1	Manual

PART No.	PARTS Per Kit	DESCRIPTION
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## Miscellaneous (Cont'd.)

347-14	1	Length RG-8/U coaxial cable
420-3	1	Motor
453-104	1	Extension shaft
455-10	3	3/8" bushing
455-31	1	1/4" bushing
456-7	1	Shaft coupling
490-6	1	5/64" Allen wrench
331-6		Solder
595-402	1	Manual

## PROPER SOLDERING TECHNIQUES

Only a small percentage of HEATHKIT equipment purchasers find it necessary to return an instrument for factory service. Of these instruments, by far the largest portion of malfunctions are due to poor or improper soldering.

If terminals are bright and clean and free of wax, frayed insulation and other foreign substances, no difficulty will be experienced in soldering. Correctly soldered connections are essential if the performance engineered into a kit is to be fully realized. If you are a beginner with no experience in soldering, a half hour's practice with some odd lengths of wire may be a worthwhile investment.

For most wiring, a 25 to 100 watt iron or its equivalent in a soldering gun is very satisfactory. A lower wattage iron than this may not heat the connection enough to flow the solder smoothly over the joint. Keep the iron tip clean and bright by wiping it from time to time with a cloth.

### CHASSIS WIRING AND SOLDERING

1. There are several types of wire furnished with this kit. Use the type of wire called for in each wiring step. In preparing a length of hookup wire, 1/4" of insulation should be removed from each end unless directed otherwise in the step.
2. To avoid breaking internal connections when stripping insulation from the leads of transformers or similar components, care should be taken not to pull directly on the lead. Instead, hold the lead with pliers while it is being stripped.

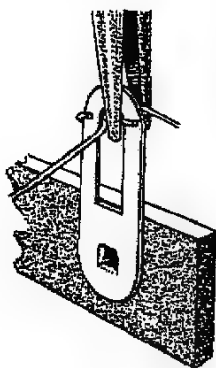
3. Leads on resistors, capacitors and similar components are generally much longer than they need to be to make the required connections. In these cases, the leads should be cut to proper length before the part is added to the chassis. In general, the leads should be just long enough to reach their terminating points.
4. Wherever there is a possibility of bare leads shorting to other parts or to the chassis, the leads should be covered with insulating sleeving. Where the use of sleeving is specifically intended, the phrase "use sleeving" is included in the associated construction step. In any case where there is the possibility of an unintentional short circuit, sleeving should be used. Extra sleeving is provided for this purpose.
5. Crimp or bend the lead (or leads) around the terminal to form a good joint without relying on solder for physical strength. If the wire is too large to allow bending or if the step states that the wire is not to be crimped, position the wire so that a good solder connection can still be made.
6. Position the work, if possible, so that gravity will help to keep the solder where you want it.
7. Place a flat side of the soldering iron tip against the joint to be soldered until it is heated sufficiently to melt the solder.
8. Then place the solder against the heated terminal and it will immediately flow over



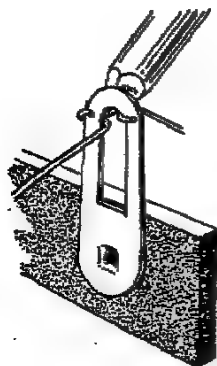
the joint; use only enough solder to thoroughly wet the junction. It is usually not necessary to fill the entire hole in the terminal with solder.

9. Remove the solder and then the iron from the completed junction. Use care not to move the leads until the solder is solidified.

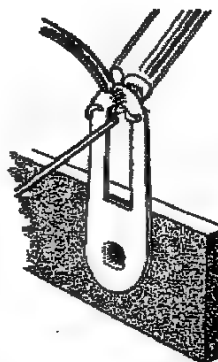
A poor or cold solder joint will usually look crystalline and have a grainy texture, or the solder will stand up in a blob and will not have adhered to the joint. Such joints should be reheated until the solder flows smoothly over the entire junction. In some cases, it may be necessary to add a little more solder to achieve a smooth bright appearance.



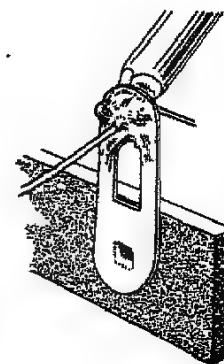
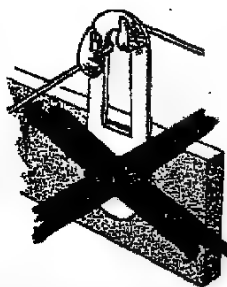
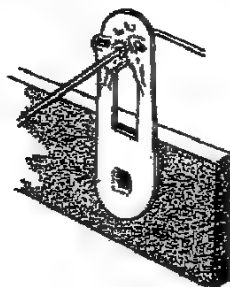
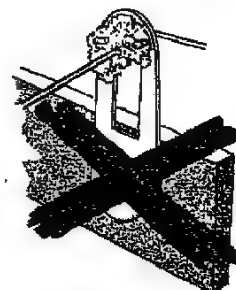
CRIMP WIRES



HEAT CONNECTION



APPLY SOLDER

ALLOW SOLDER  
TO FLOWCOLD SOLDER JOINT  
CONNECTION INSUFFICIENTLY  
HEATEDPROPER SOLDER  
CONNECTIONCOLD SOLDER JOINT  
CONNECTION MOVED  
WHILE COOLING

ROSIN CORE SOLDER HAS BEEN SUPPLIED WITH THIS KIT. THIS TYPE OF SOLDER MUST BE USED FOR ALL SOLDERING IN THIS KIT. ALL GUARANTEES ARE VOIDED AND WE WILL NOT REPAIR OR SERVICE EQUIPMENT IN WHICH ACID CORE SOLDER OR PASTE FLUXES HAVE BEEN USED. IF ADDITIONAL SOLDER IS NEEDED, BE SURE TO PURCHASE ROSIN CORE (60:40 or 50:50 TIN-LEAD CONTENT) RADIO TYPE SOLDER.

## STEP-BY-STEP PROCEDURE

The following instructions are presented in a logical step-by-step sequence to enable you to complete your kit with the least possible confusion. Be sure to read each step all the way through before beginning the specified operation. Also read several steps ahead of the actual step being performed. This will familiarize you with the relationship of the subsequent operations. When the step is completed, check it off in the space provided. This is particularly important as it may prevent errors or omissions, especially if your work is interrupted. Some kit builders have also found it helpful to mark each lead in colored pencil on the Pictorial as it is added.

The fold-out diagrams in this manual may be removed and attached to the wall above your working area; but, because they are an integral part of the instructions, they should be returned to the manual after the kit is completed.

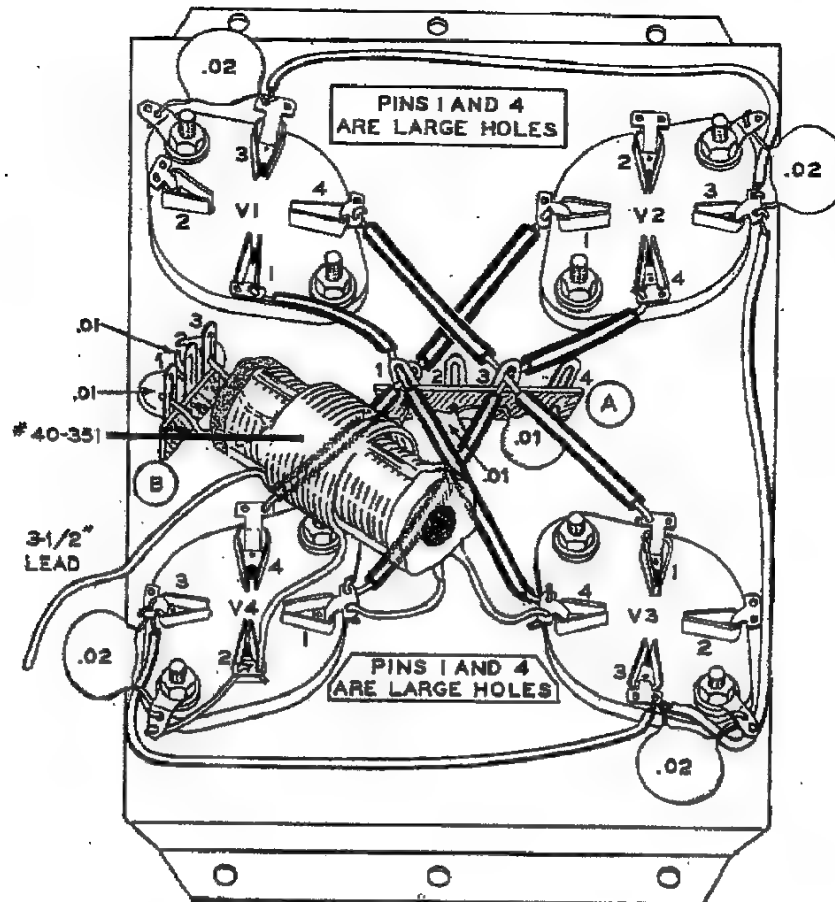
In general, the illustrations in this manual correspond to the actual configuration of the kit; however, in some instances the illustra-

tions may be slightly distorted to facilitate clearly showing all of the parts.

The abbreviation "NS" indicates that a connection should not be soldered yet as other wires will be added. When the last wire is installed, the terminal should be soldered and the abbreviation "S" is used to indicate this. Note that a number will appear after each solder instruction. This number indicates the number of leads that are supposed to be connected to the terminal in point before it is soldered. For example, if the instruction reads, "Connect a lead to lug 1 (S-2)," it will be understood that there will be two leads connected to the terminal at the time it is soldered. (In cases where a lead passes through a terminal or lug and then connects to another point, it will count as two leads, one entering and one leaving the terminal.)

The steps directing the installation of resistors include color codes to help identify the parts. Also, if a part is identified by a letter-number designation on the Schematic, its designation will appear in the construction step which directs its installation.

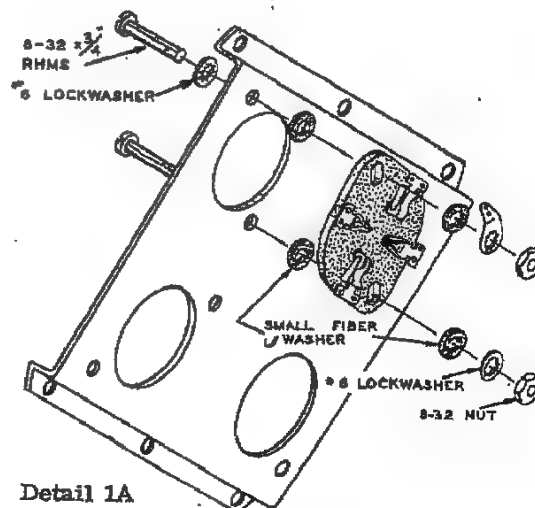
## STEP-BY-STEP ASSEMBLY



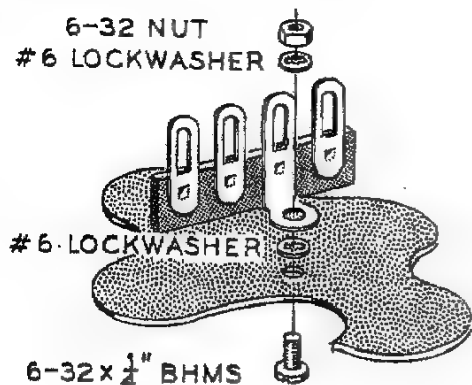
Pictorial 1

Refer to Pictorial 1 for the following steps.

- ( ) Referring to Detail 1A, mount a tube socket at V1 on the amplifier tube mounting bracket. Use 6-32 x 3/4" RHMS. Place a #6 fiber washer on each side of the tube socket and use a #6 solder lug, instead of a lockwasher, on the screw between lugs 2 and 3, as shown in Pictorial 1. Secure with 6-32 nuts. Take care to properly orient the socket with the large holes at lugs 1 and 4. Center it in its mounting hole before tightening the screws.
- ( ) In the same manner, mount tube sockets at V2, V3, and V4.



Detail 1A



Detail 1B

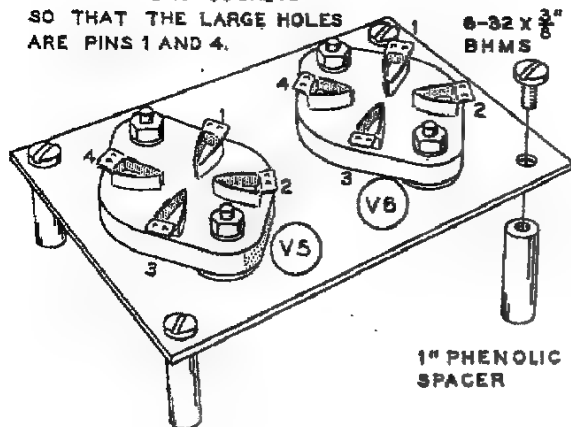
- ( ) Mount 4-lug terminal strip A. Use a 6-32 x 1/4" BHMS, #6 lockwashers, and a 6-32 nut as shown in Detail 1B. Place a lockwasher on each side of the terminal strip mounting foot, and orient the terminal strip as shown in Pictorial 1. Note that lug 2 of this terminal strip is grounded through the mounting foot.
- ( ) In the same manner, mount a 3-lug terminal strip at location B. Orient as shown in Pictorial 1.
- ( ) C1. Connect a .01  $\mu$ fd disc capacitor between the bottom hole in lug 1 (S-1) and the bottom hole in lug 3 (NS) of terminal strip A.
- ( ) C2. Connect another .01  $\mu$ fd disc capacitor between the bottom hole in lug 3 (S-2) and the bottom hole in lug 4 (S-1) of terminal strip A.
- ( ) Connect one end of a length of #14 bare wire through lug 1 of terminal strip A (NS) to lug 1 of tube socket V1 (S-1). Use sleeving. Connect the other end of this wire to lug 4 of tube socket V3 (NS). Use sleeving.
- ( ) Connect one end of a length of #14 bare wire through lug 1 of terminal strip A (NS) to lug 1 of tube socket V2 (S-1). Use sleeving. Connect the other end of this wire to lug 4 of tube socket V4 (S-1). Use sleeving. Now solder lug 1 (S-4).
- ( ) Connect one end of a length of #14 bare wire through lug 3 of terminal strip A (NS) to lug 4 of tube socket V2 (S-1). Use sleeving. Connect the other end of this wire to lug 1 of tube socket V4 (NS). Use sleeving.
- ( ) Connect one end of a length of #14 bare wire through lug 3 of terminal strip A (NS) to lug 4 of tube socket V1 (S-1). Use sleeving.

ing. Connect the other end of this wire to lug 1 of tube socket V3 (S-1). Use sleeving. Now solder lug 3 (S-4).

- ( ) Connect a length of yellow hookup wire from lug 3 of tube socket V1 (NS) to lug 3 of tube socket V2 (NS).
- ( ) Connect a length of yellow hookup wire from lug 3 of tube socket V2 (NS) to lug 3 of tube socket V3 (NS).
- ( ) Connect a length of yellow hookup wire from lug 3 of tube socket V3 (NS) to lug 3 of tube socket V4 (NS).
- ( ) C3. Connect a .02  $\mu$ fd disc capacitor from lug 3 of tube socket V1 (S-2) to the adjacent solder lug (S-1).
- ( ) C4. Connect a .02  $\mu$ fd disc capacitor from lug 3 of tube socket V2 (NS) to the adjacent solder lug (S-1).
- ( ) C5. Connect a .02  $\mu$ fd disc capacitor from lug 3 of tube socket V3 (S-3) to the adjacent solder lug (S-1).
- ( ) C6. Connect a .02 disc capacitor from lug 3 of tube socket V4 (S-2) to the adjacent solder lug (NS).
- ( ) Connect a length of #14 bare wire from lug 2 of tube socket V4 (NS) to the adjacent solder lug (S-2).
- ( ) C23. Connect a .01  $\mu$ fd disc capacitor between the bottom hole in lug 1 (S-1) and the bottom hole in lug 2 (NS) of terminal strip B.
- ( ) C24. Connect a .01  $\mu$ fd disc capacitor between the bottom hole in lug 3 (S-1) and the bottom hole in lug 2 (S-2) of terminal strip B.
- ( ) L2. Orient the filament choke as shown in Pictorial 1, with the long neutralizing lead nearest terminal strip B. Connect one of the filament leads, at the near end of the choke, to lug 1 of tube socket V4 (S-2) and the other filament lead, at the same end of the choke, to lug 4 of tube socket V3 (S-2).
- ( ) Connect one of the filament leads, at the other end of the choke, to lug 1 of terminal strip B (NS) and connect the other filament lead to lug 3 of terminal strip B (NS).
- ( ) Connect the shorter neutralizing lead to lug 2 of tube socket V4 (S-2). Leave the longer neutralizing lead free at this time.

Set this subassembly aside until it is called for later in the instructions.

NOTE - ORIENT SOCKETS  
SO THAT THE LARGE HOLES  
ARE PINS 1 AND 4.

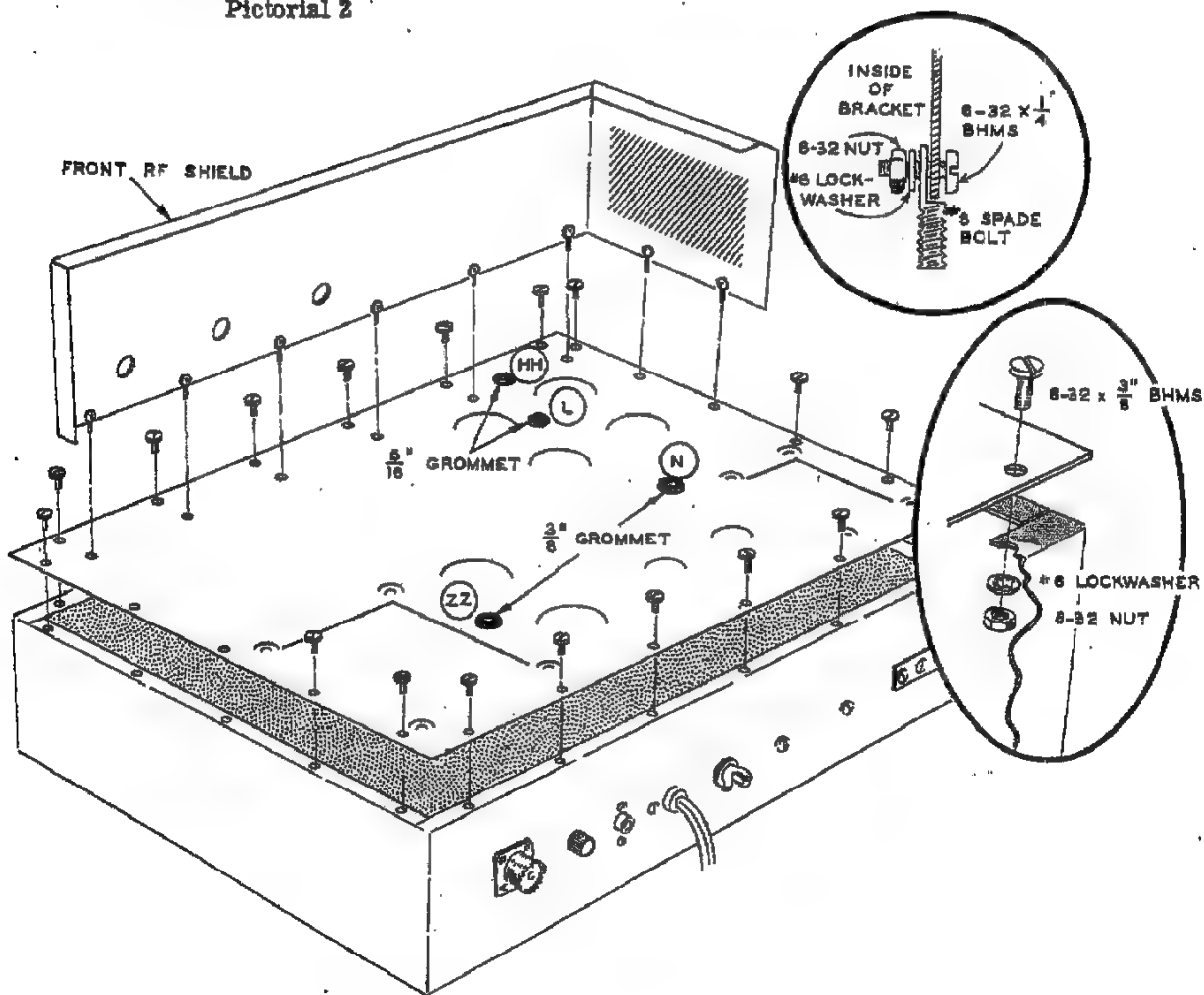


Pictorial 2

Refer to Pictorial 2 for the following steps.

- ( ) Locate the rectifier tube mounting plate. Referring back to Detail 1A, mount tube sockets V5 and V6. Position the sockets as shown, with the large holes of each socket for lugs 1 and 4. Use small fiber washers on each side of the socket as shown in Detail 1A, but do not use #6 solder lugs.
- ( ) Mount four phenolic spacers, using 6-32 x 3/8 inch BHMS as shown.

Set this subassembly aside until it is called for later.



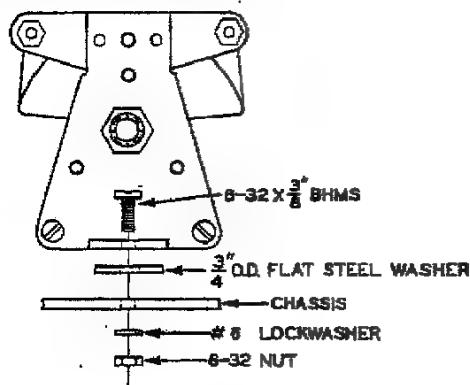
Pictorial 3

Refer to Pictorial 3 for the following steps.

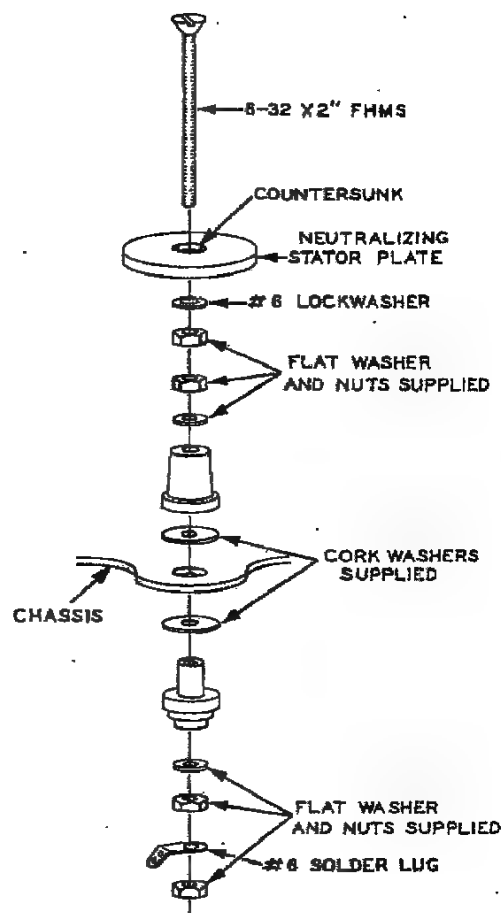
- ( ) Mount the chassis top plate to the chassis base as shown in Pictorial 3. Use 6-32 x 3/8" BHMS, lockwashers and nuts. Do not place screws in the mounting holes that will be used for the front and rear RF shield spade bolts.
- ( ) Mount #6 spade bolts to the front RF shield. Use 6-32 x 1/4" BHMS, #6 lockwashers and 6-32 nuts as shown in Pictorial 3.
- ( ) Mount the front RF shield to the chassis top plate, using #6 lockwashers and 6-32 nuts.
- ( ) Install 5/16" grommets in holes L and HH.
- ( ) Install 3/8" grommets in holes N and ZZ.

Refer to Pictorial 4 (fold-out from Page 17) for the following steps.

- ( ) C10. Mount the TUNING capacitor at C, as shown in Detail 4A. Use 6-32 x 3/8" BHMS. Place a #10 flat washer between each mounting foot and the chassis top plate.

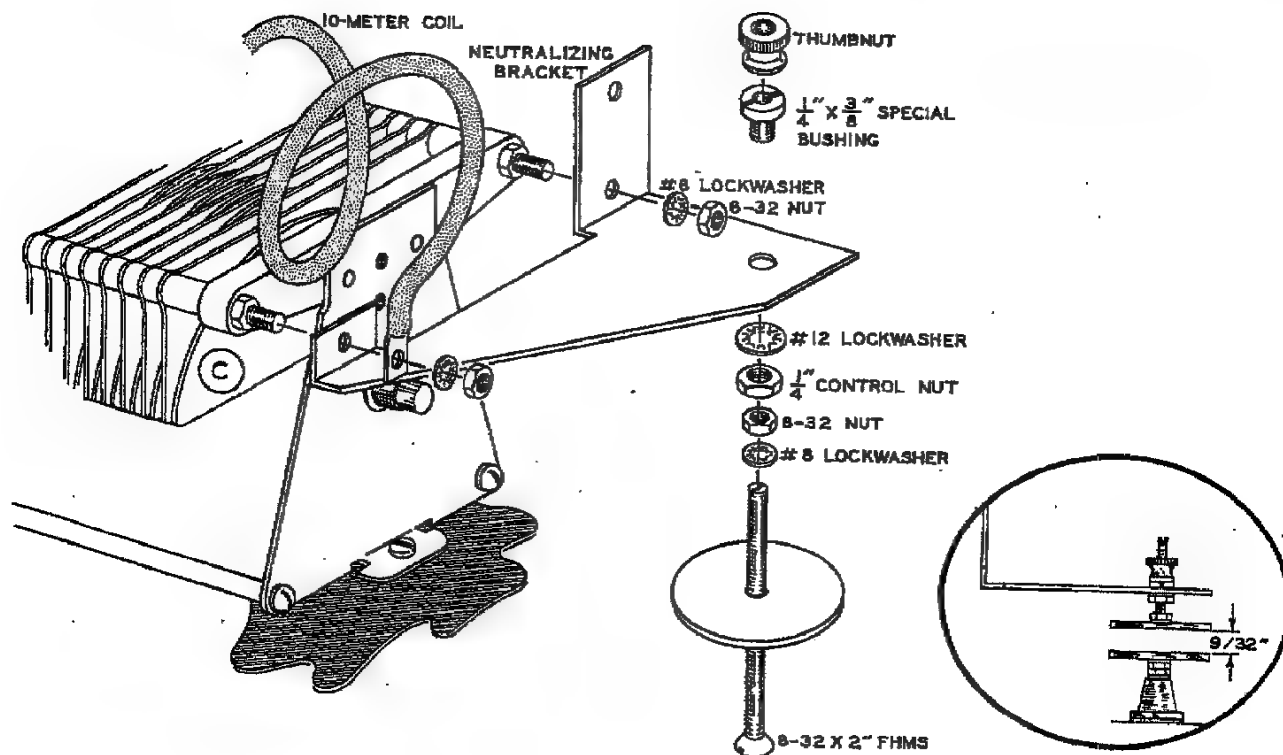


Detail 4A



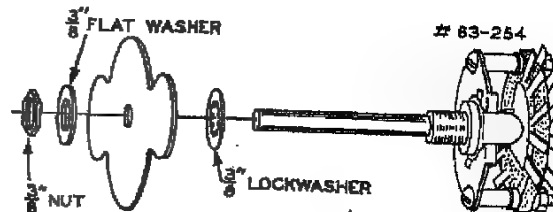
Detail 4B

- ( ) C9. Assemble and mount the neutralizing capacitor stator plate to the chassis top plate at D. See Detail 4B. The stud supplied with the feed-through insulator is not used. Replace it with a 6-32 x 2" FHMS.



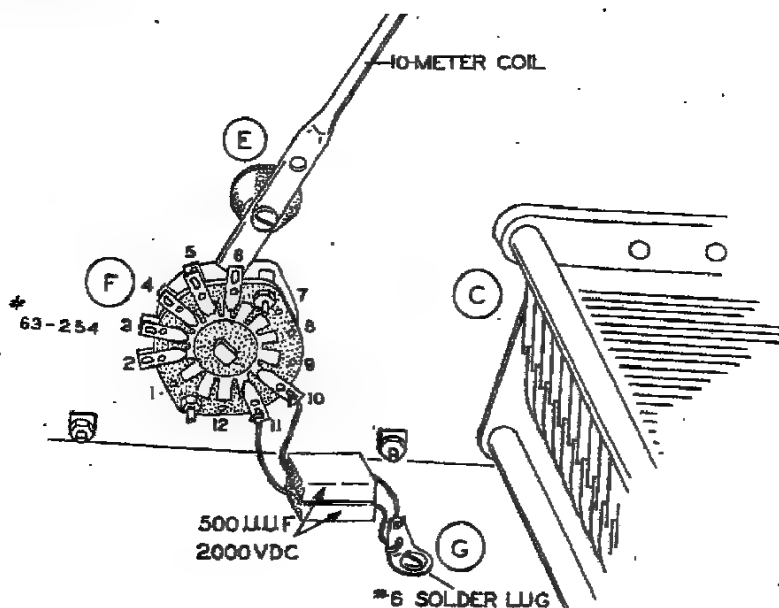
Detail 4C

- ( ) Now assemble the neutralizing capacitor rotor and bracket as shown in Detail 4C. Mount this bracket on the two studs of TUNING capacitor C. Secure only the right side, using a #6 lockwasher and 6-32 nut. (The 10-meter coil will be mounted on the left side later.) Notice that the hole in the neutralizing bracket is slightly oversized for the 1/4" bushing. Before securing the 1/4" nut, position the bushing so that the rotor plate is aligned directly over the stator.
- ( ) See Detail 4C inset for proper measurement. After insuring that the capacitor plates are properly aligned, set the plates so that they are 9/32" apart and tighten the thumbnut. This preset distance gives proper neutralizing and will not need further adjustments. (Because of the unconventional circuitry involved, the more standard methods of neutralizing will prove ineffective.)
- ( ) Use an icepick or similar instrument to enlarge the holes in lugs 3, 4, and 5 of the ceramic BAND switch (#63-254). The holes should be made large enough to accept #12 bare wire. Refer to Figure 4F for numbering.
- ( ) Referring to Detail 4D, temporarily mount the ceramic BAND switch at F. Place a control lockwasher between the switch and panel, and use a control flat washer and control nut outside of the panel. Do not tighten securely yet.



Detail 4D





Detail 4F

- ( ) Referring to Detail 4E, mount ceramic standoff insulator E. Use a #6 lockwasher instead of the flat washer supplied with the insulator. The cork washer goes between the insulator body and the RF shield panel. Remove the hardware from the top of the insulator as it will not be used.

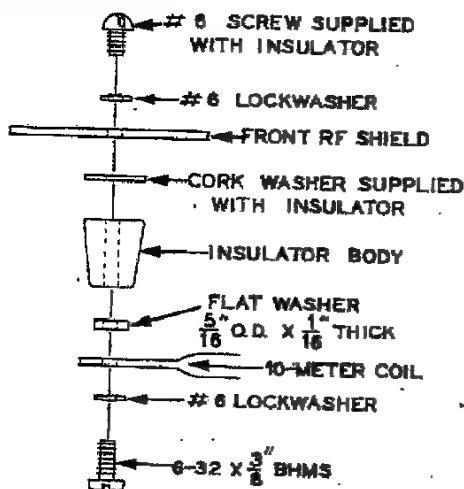
end of this coil to TUNING capacitor C. Use a #6 lockwasher and 6-32 nut as shown in Detail 4C.

- ( ) Position ceramic BAND switch F so the extended end of the 10-meter coil falls between the two number 6 lugs. Now secure the BAND switch by tightening its control nut. See Detail 4F.

- ( ) Using long-nose pliers, form each number 6 lug of the BAND switch so they are against the extension of the 10-meter coil. Securely solder each number 6 lug to the coil.

- ( ) Mount a #6 solder lug at G. Use a 6-32 x 1/4" BHMS, #6 lockwasher and 6-32 nut.

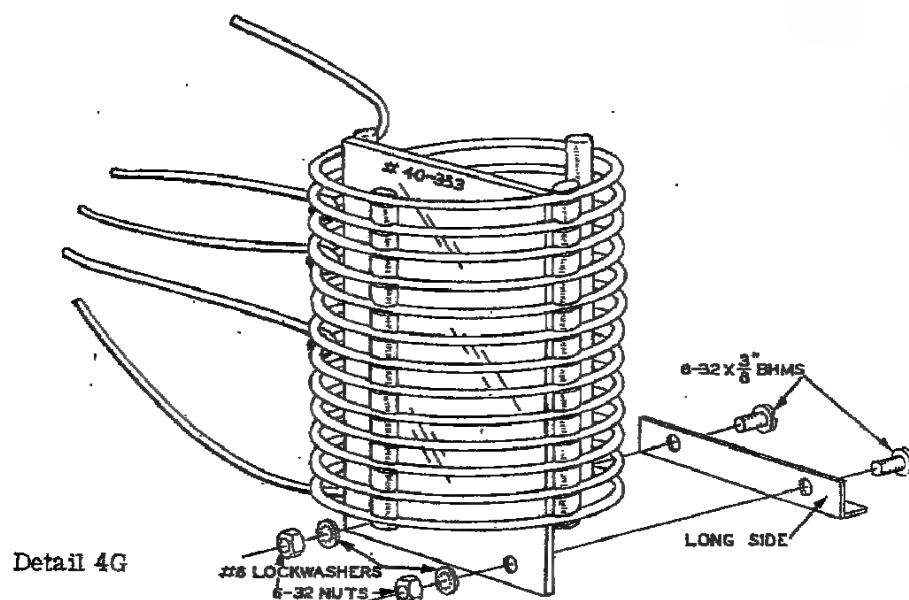
- ( ) C12. Referring to Detail 4F, connect a 500 μf mica capacitor from lug 11 of BAND switch F (S-1) to ground lug G (NS). Do not allow the lead between the capacitor and lug 11 to touch the chassis. (Note that the leads are not spaced evenly between edges of the capacitors. Allow maximum spacing between the chassis and the points where the leads exit from the capacitors.)



Detail 4E

- ( ) L3. Mount the 10-meter tank coil as shown in Detail 4F. Use a 6-32 x 3/8" BHMS through the lower hole in the tank coil, through a 1/16" thick small flat washer, and into standoff insulator E. Secure the other

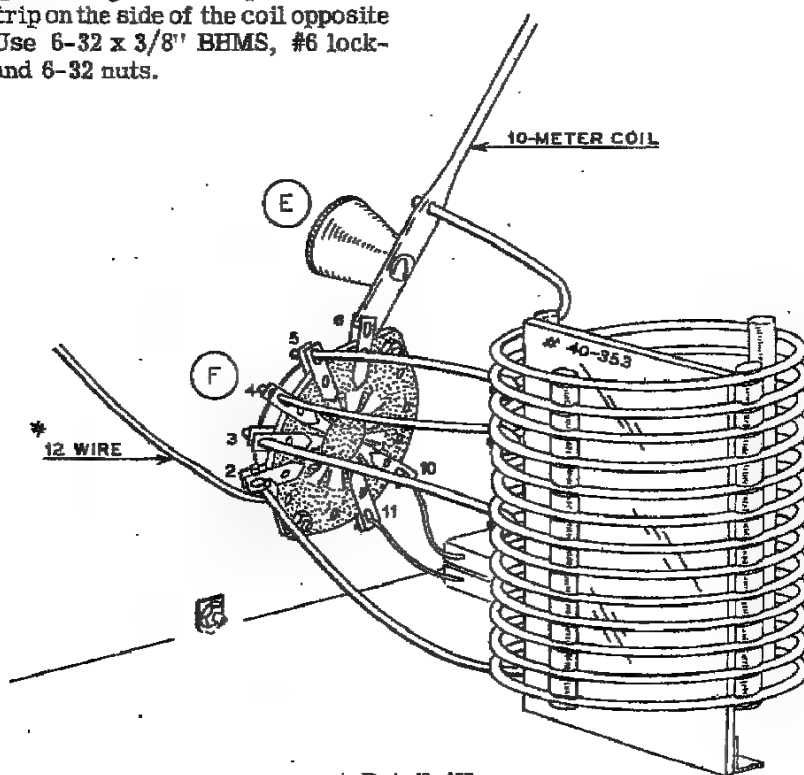
- ( ) C11. Connect another 500 μf mica capacitor from lug 10 of BAND switch F (S-1) to ground lug G (S-2).



Detail 4G

( ) L4. Referring to Detail 4G, install the multi-band coil on its mounting bracket. Note that one flange of this bracket is  $1/16$ " wider than the other flange. The long flange should be placed against the plastic coil mounting strip on the side of the coil opposite its taps. Use 6-32 x  $3/8$ " BHMS, #6 lockwashers, and 6-32 nuts.

( ) Referring to Pictorial 4 and Detail 4H, place the coil on the top plate, over the two mounting holes behind BAND switch F.

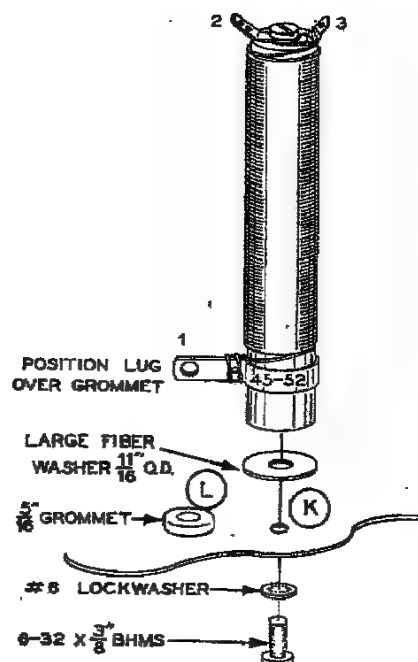


Detail 4H

- ( ) Form the coil leads to fit into the 10-meter coil and into BAND switch lugs as follows:

Top lead	through the hole in the 10-meter coil.
Upper tap	through lug 5 of the BAND switch.
Middle tap	through lug 4 of the BAND switch.
Lower tap	through lug 3 of the BAND switch.
Bottom lead	Form a right-angle bend in this lead so it will fit between the number 2 lugs of the BAND switch.

- ( ) After forming the coil leads as directed in the previous step, secure the coil to the top plate. Use 6-32 x 3/8" BHMS, #6 lockwashers, and 6-32 nuts.
- ( ) Double check to be sure that no excess pressure is being applied to the BAND switch by the coil leads. Then, solder lug 2 (S-1), lug 3 (S-1), lug 4 (S-1), and lug 5 (S-1) of the BAND switch. Solder the top coil lead in the hole of the 10-meter coil (S-1).
- ( ) C13. Mount LOADING capacitor H. Use #6 lockwashers and 6-32 nuts on the mounting studs.
- ( ) Form a hook at one end of a length of #12 bare wire. Secure this hook over the #10 wire going to lug 2 of BAND switch F. Pass the other end of this #12 bare wire through lug 10 of LOADING capacitor H (NS) and connect it to the solder lug under screw 4 of H (S-1). Position the wire as shown in Pictorial 4 and Detail 4H to clear the LOADING capacitor frame. Now solder lug 10 of capacitor H (S-2) and the eyelet at lug 2 of the BAND switch (S-1).
- ( ) Mount a #6 solder lug at J. Use a 6-32 x 1/4" BHMS, #6 lockwasher, and 6-32 nut.
- ( ) Referring to Detail 4J, mount the ceramic form RF choke at K. Place a large flat fiber washer between the ceramic coil form and the chassis. Secure with a 6-32 x 3/8" BHMS, using a #6 lockwasher under the screw head.

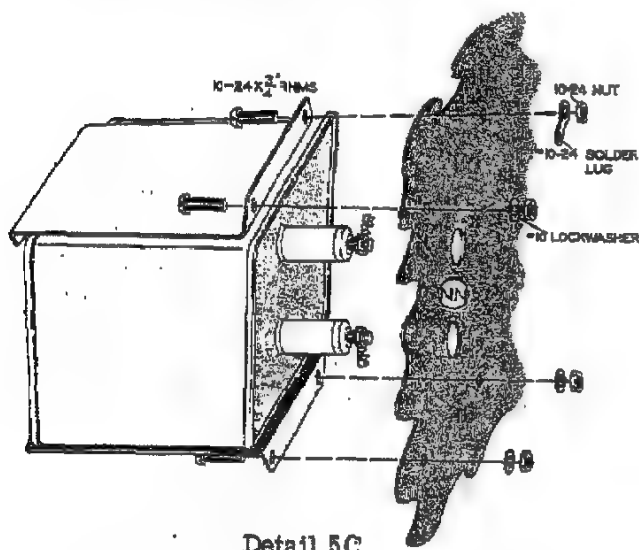


Detail 4J

- ( ) C8. Locate the 1000  $\mu\text{f}$ , 5 kv ceramic tubular capacitor. Mount this capacitor to one end of the silver plated copper strap. Use a 6-32 x 1/4" BHMS, with a #6 lockwasher under the screw head.
- ( ) Mount the other end of the copper strap to the top of the RF choke as shown in Pictorial 4. First remove the screw that is in the choke form. Then, place the same side of the strap that the tubular capacitor is mounted on, over the end of the choke form. Secure with the screw that was removed from the choke.
- ( ) Orient and form the copper strap as shown in Pictorial 4. Now secure the tubular capacitor to the neutralizing bracket. Use a 6-32 x 1/4" BHMS, with a #6 lockwasher under the screw head.
- ( ) C7. Connect the .001  $\mu\text{f}$  3 kv disc capacitor from lug 1 of RF choke strap K (NS) to solder lug J (S-1).
- ( ) Pass one end of the blue high-voltage wire through grommet L and connect it to lug 1 of strap K (S-2).

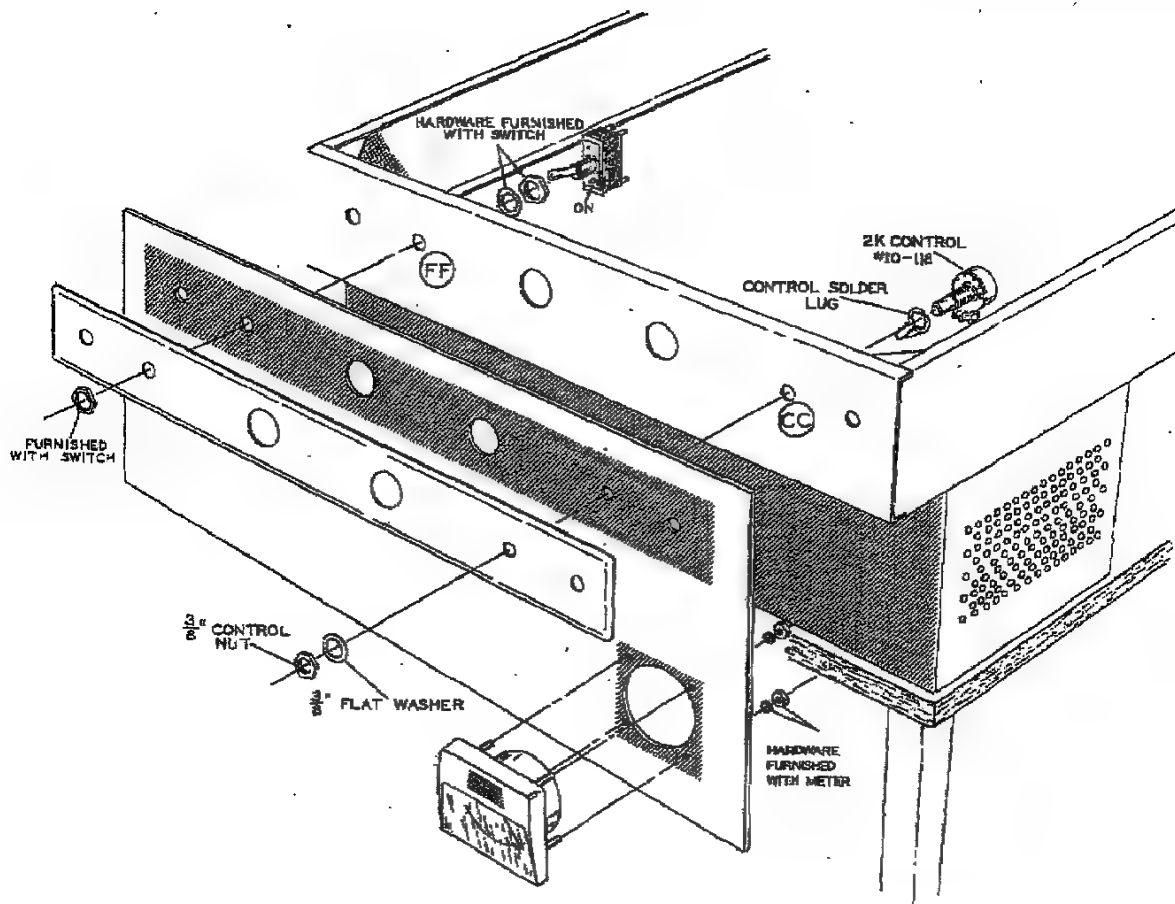


- ( ) Mount a 6-lug terminal strip at U. Use 6-32 x 1/4" BHMS and orient as shown.
- ( ) Mount the phono socket at V. Orient as shown. Use 6-32 x 1/4" BHMS.
- ( ) C14. Mount the variable mica capacitor at W. Use 6-32 x 1/4" BHMS.
- ( ) C19. Mount the high-voltage filter capacitor on top of the chassis at NN. Use the two mounting brackets and 10-24 x 3/4" RHMS. Place a #10 solder lug under the nut at location AE. Refer to Detail 5C.



Detail 5C

- ( ) L5. Mount the high-voltage swinging choke at Z. Use four 8-32 nuts with lockwashers. Orient as shown with the choke leads toward the filter capacitor.
- ( ) Mount the rectifier filament transformer at AB. Use two 8-32 x 3/8" BHMS. Orient with the large green leads toward the rectifier tube sockets. Place a #8 solder lug under the nut closest to the rectifier tube assembly. Use a lockwasher under the other nut.
- ( ) Cut the leads of the filament and bias transformer as follows: Yellow-green lead 3", green lead closest to mounting foot 3-1/2", green lead farthest from mounting foot 2-1/2". Strip 1/4" of insulation from the ends of these leads and tin.
- ( ) Mount the filament transformer at AC. Use four 8-32 x 3/8" BHMS, #8 lockwashers, and 8-32 nuts. Orient with the large green leads toward the amplifier tube assembly.
- ( ) Mount a 6-lug terminal strip at KK. Orient as shown and secure with a 6-32 x 1/4" BHMS, #6 lockwashers, and a 6-32 nut.
- ( ) Mount a #6 solder lug at AA. Orient as shown in Pictorial 5 and secure with a 6-32 x 1/4" BHMS and 6-32 nut.
- ( ) Mount the rectifier tube bracket. Use 6-32 x 3/8" BHMS. Orient with the large socket pin holes toward the filter capacitor.
- ( ) Mount the high-voltage plate transformer at Y. Use four #10 nuts with lockwashers. Orient as shown with the two red leads toward the rectifier tube sockets.
- ( ) Mount the shaft coupling on the end of the shaft of tuning capacitor C. Secure with a 6-32 x 1/4" BHMS.
- ( ) Mount brass bushings in the front panel at TUNING, BAND and LOADING. Secure with 3/8" control lockwashers and nuts on the back side of the panel.



Pictorial 6

Refer to Pictorial 6 for the following steps.

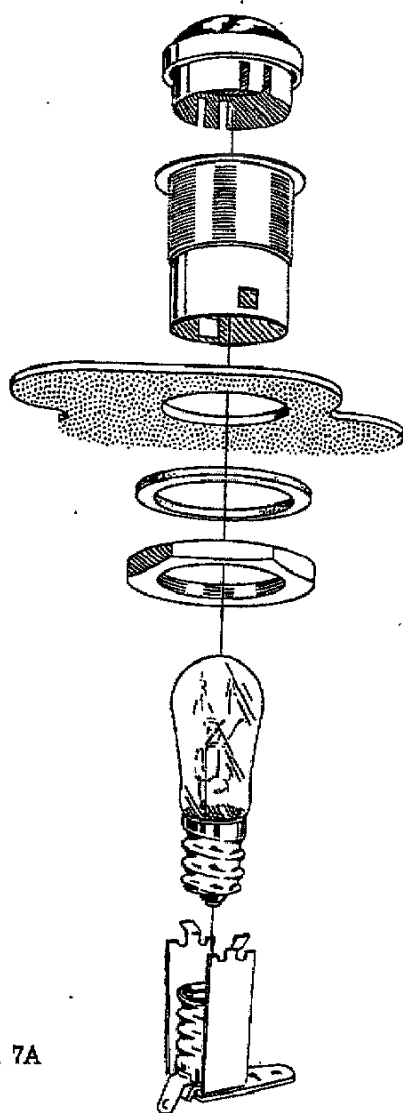
- ( ) Mount the meter to the front panel as shown. Use the hardware supplied with the meter. Do not overtighten.
- ( ) C20. Connect a .01 disc capacitor between the two meter terminals (NS).
- ( ) Connect a 9" length of red hookup wire to the positive (+) meter terminal (S-2) and connect a 9" length of black hookup wire to the other meter terminal (S-2). Twist these wires together for a distance of about 6".

NOTE: The following step will be easier if the amplifier chassis is placed on the edge of your table or workbench, as shown in Pictorial 6.

- ( ) Mount the front panel to the chassis base, placing the LOADING capacitor and BAND switch shafts through the proper holes. Feed this twisted pair of wires coming from the meter down through grommet HH.
- ( ) R12. Place the escutcheon on the front of the panel and mount both the escutcheon and front panel to the chassis by securing SENSITIVITY control CC, as shown in Pictorial 6. Orient the control solder lug as shown. Do not tighten the control nut yet.

Refer to Pictorial 7 (fold-out from Page 25) for the following steps.

- ( ) Mount FUNCTION switch BB. Orient the switch as shown, with a lockwasher between switch and chassis apron. Secure with a flat washer and a control nut. Do not tighten yet.



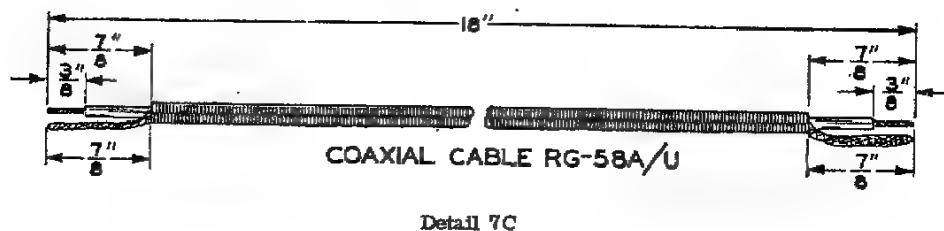
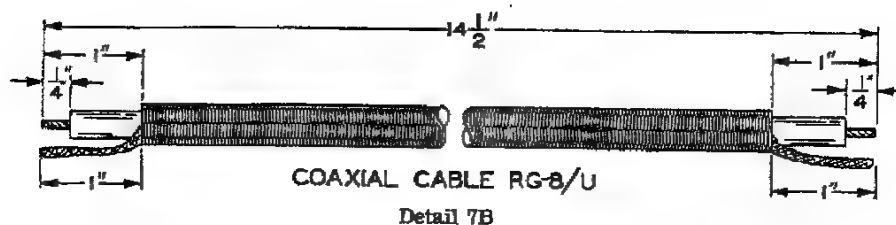
Detail 7A

- ( ) Referring to Detail 7A, mount the green pilot lamp at DD. First, disassemble the socket and secure it with the fiber washer and nut supplied. Screw a bulb into the socket base and reassemble as shown.
- ( ) In a similar manner, mount the red pilot lamp at EE.
- ( ) Mount a DPST switch at FF, as shown in Pictorials 6 and 7. Orient the switch with its ON position up, as shown in Pictorial 6.
- ( ) In a similar manner, mount a DPST switch at GG. Tighten all control and switch nuts to hold the panel and escutcheon securely.

- ( ) Cut the red-yellow lead of plate transformer Y to 7-1/2" and strip 1/2" of insulation from the end.
- ( ) Cut the black lead of swinging choke Z to 7-1/2" and strip 3/8" of insulation from the end.
- ( ) Slip the 4" length of 1/4" ID plastic sleeving over the red-yellow lead. Twist the ends of the red-yellow and the black lead together and solder the connection. Slide the plastic sleeving over the connection and tape it in place.
- ( ) Place a plastic cable clamp under the lockwasher and nut at location MM. Orient as shown and secure after placing the blue high voltage wire through the clamp.
- ( ) Cut the blue high voltage wire to length and connect it to lug 4 of tube socket V6 (NS).
- ( ) Connect one of the green leads from rectifier filament transformer AB to lug 1 of tube socket V5 (NS). Save the excess lead wire for use later.
- ( ) Connect the other green lead coming from filament transformer AB to lug 4 of tube socket V5 (NS). Save the excess lead.
- ( ) Connect a length of blue high-voltage wire from lug 2 of high-voltage filter capacitor NN (S-1) to lug 4 of tube socket V5 (NS).
- ( ) Using the excess green lead that was cut from rectifier filament transformer AB, connect a lead from lug 4 of tube socket V5 (S-3) to lug 4 of tube socket V6 (NS). Connect a lead from lug 1 of tube socket V5 (S-2) to lug 1 of tube socket V6 (S-1).
- ( ) Connect a length of #14 bare wire from lug 1 of filter capacitor NN (S-1) to solder lug AE (S-1). Be sure the nuts on terminals 1 and 2 of filter capacitor NN are tight.
- ( ) Connect one of the black leads coming from filament transformer AB to lug 3 of terminal strip AF (NS).
- ( ) Connect the other black lead coming from filament transformer AB to lug 1 of terminal strip AF (NS).

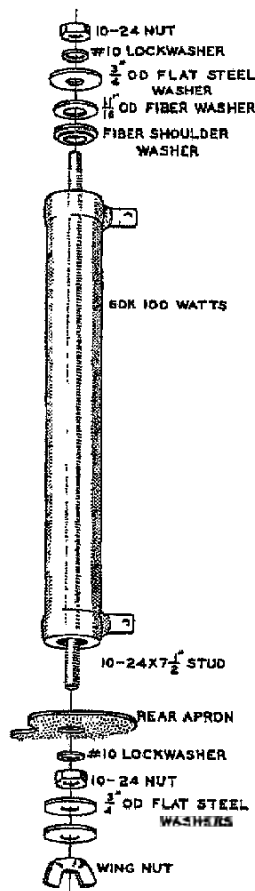


- ( ) Connect a length of black hookup wire from lug 1 of terminal strip AF (NS) to lug 6 of terminal strip KK (NS).
- ( ) Connect a length of black hookup wire from lug 3 of terminal strip AF (NS) to lug 5 of terminal strip KK (NS).
- ( ) Connect a length of #14 bare wire from lug 2 of terminal strip AF (S-1) to lug 2 of screw terminal strip T (S-1).
- ( ) Connect one lead of the twisted pair coming through grommet N to lug 3 of terminal strip AF (NS).
- ( ) Connect the other lead of this twisted pair to lug 1 of terminal strip AF (NS).
- ( ) Connect a length of black hookup wire from lug 3 of terminal strip AF (S-4) to lug 4 of terminal strip U (NS).
- ( ) Connect a length of black hookup wire from lug 1 of terminal strip AF (S-4) to lug 4 of switch GG (NS).
- ( ) Connect the nearest black lead coming from plate transformer Y to lug 4 of terminal strip U (NS).
- ( ) Connect a length of black hookup wire from lug 1 of switch FF (NS) to lug 1 of pilot light DD (S-1).
- ( ) Connect a length of #14 bare wire from lug 1 of switch FF (S-2) to lug 4 of switch GG (S-2).
- ( ) Run a length of #14 bare wire through lug 3 (NS) and through lug 2 (NS) of switch FF. Connect the end of this wire to lug 3 of switch GG (S-1). Now solder lugs 2 (S-1) and 3 (S-1) of switch FF.
- ( ) Using #14 bare wire, connect the bottom holes of lugs 1 (S-1) and 2 (S-1) of terminal strip U. Solder only the bottom holes, making sure the solder does not short to the chassis.
- ( ) Using the large #14 insulated wire, connect a length from lug 1 of terminal strip U (S-1) to the bare wire that is connected between lug 2 of switch FF and lug 3 of switch GG (S-1).
- ( ) Connect a length of black hookup wire from lug 1 of pilot light EE (S-1) to lug 2 of switch GG (NS).
- ( ) Connect the remaining black lead coming from the plate transformer Y to lug 2 of switch GG (S-2).
- ( ) Connect a length of #14 insulated hookup wire from lug 4 of switch FF (S-1) to lug 1 of switch GG (S-1).
- ( ) Connect a length of black hookup wire from lug 2 of pilot light DD (S-1) to lug 2 of pilot light EE (NS).
- ( ) Connect a length of black hookup wire from lug 2 of pilot light EE (S-2) to lug 4 of terminal strip U (NS).
- ( ) Connect a length of blue hookup wire from lug 6 of terminal strip U (NS) to lug 3 of control CC (NS). Route the wire as shown.
- ( ) Connect the crystal diode between lug 6 (S-2) and lug 5 (NS) of terminal strip U. Orient as shown with the band end of diode to lug 6. When soldering the diode lead, protect the diode body from heat by clamping a pair of long-nose pliers over the lead between the diode body and the solder joint. Refer to Detail 7F.
- ( ) R13. Connect the 2.2 K $\Omega$  (red-red-red) 1 watt resistor between lugs 5 (NS) and 3 (NS) of terminal strip U.
- ( ) R14. Connect the 10 K $\Omega$  (brown-black-orange) 2 watt resistor between lug 5 of terminal strip U (S-3) and lug 1 of capacitor W (NS).
- ( ) C22. Connect a .005  $\mu$ fd disc capacitor (1400 V) between lugs 4 (NS) and 3 (NS) of terminal strip U.
- ( ) C21. Connect a .005  $\mu$ fd disc capacitor (1400 V) between lugs 3 (NS) and 2 (NS) of terminal strip U.
- ( ) Connect a length of #14 bare wire between lug 2 of capacitor W (NS) and lug 1 of socket V (S-1).
- ( ) Connect the 1.1 mh RF choke between lug 3 of terminal strip U (S-4) and lug 2 of capacitor W (S-2).



- ( ) Prepare a length of RG-8/U as shown in Detail 7B.
- ( ) Solder the center conductor at one end of this cable in the center pin of coax connector R (S-1).
- ( ) Connect and solder the shield lead to the solder lug adjacent to connector R (S-1).
- ( ) Run the other end of the RG-8/U coax cable up through hole AG and leave the end free temporarily.
- ( ) Form a hook at the end of a length of #14 bare wire. Solder this hook around the center pin of coax connector R (S-1). Connect the other end to lug 1 of capacitor W (S-2).
- ( ) Prepare a length of RG-58A/U as shown in Detail 7C.
- ( ) Solder the center conductor at one end of this coax cable in the center pin of coax connector P (S-1).
- ( ) Wrap and solder the shield lead to the solder lug adjacent to coax connector P (S-1).
- ( ) Route the coax under transformer AC as shown and connect the center conductor at the other end to lug 4 of terminal strip A (S-1).
- ( ) Solder the shield lead to lug 2 of terminal strip A (S-1).
- ( ) Connect the shortest green lead of the filament transformer to lug 1 of terminal strip B (S-2).
- ( ) Connect the other green lead to lug 3 of terminal strip B (S-2).
- ( ) Connect the green-yellow lead to solder lug AA (S-1).
- ( ) Solder the long neutralizing lead coming from the filament choke, nearest terminal strip B, to the solder lug on ceramic standoff D (S-1). Use sleeving.
- ( ) Connect a length of white wire from lug 1 of terminal strip JJ (NS) to lug 11 of switch BB (S-1).
- ( ) Connect a length of #14 bare wire from lug 3 (S-1) to 4 (NS) of terminal strip JJ.
- ( ) R11. Connect a 10 K $\Omega$  (brown-black-orange) 1/2 watt resistor between lugs 1 (S-2) and 2 (NS) of terminal strip JJ.
- ( ) R4. Connect a 20  $\Omega$  (red-black-black) 2 watt resistor between lugs 2 (NS) and 4 (NS) of terminal strip JJ.

- ( ) R5. Connect another 20  $\Omega$  2 watt resistor between lugs 2 (NS) and 4 (S-3) of terminal JJ (NS).
- ( ) Connect the red lead coming from filter choke Z to lug 2 of terminal strip JJ (S-4).
- ( ) Connect a length of yellow hookup wire from lug 1 of screw terminal strip T (NS) to lug 3 of terminal strip KK (NS).
- ( ) Connect a length of yellow hookup wire from lug 1 of terminal strip TA (NS) to lug 7 of switch BB (NS).
- ( ) Connect a length of yellow hookup wire from lug 3 of terminal strip TA (NS) to lug 1 of terminal strip KK (NS).
- ( ) C16. Connect a .005  $\mu$ fd (1400 V) disc capacitor between lugs 6 (NS) and 4 (NS) of terminal strip KK. Refer to Detail 7G.
- ( ) C17. Connect a .005  $\mu$ fd (1400 V) disc capacitor between lugs 5 (NS) and 4 (S-2) of terminal strip KK.
- ( ) Connect one of the black leads coming from the filament transformer to lug 6 of terminal strip KK (S-3).
- ( ) Connect the other black lead coming from the filament transformer to lug 5 of terminal strip KK (S-3).
- ( ) Connect one of the orange leads coming from the filament transformer to lug 3 of terminal strip KK (S-2).
- ( ) Connect the other orange lead coming from the filament transformer to lug 2 of terminal strip KK (NS).
- ( ) Connect the silicon diode rectifier from lug 1 (S-2) to lug 2 (S-2) of terminal strip KK. Orient the diode so that the arrow (positive end) points toward the end connected to lug 2.
- ( ) R1. Connect the 11  $\Omega$  5 watt resistor from lug 1 of terminal strip TA (NS) to lug 1 of terminal strip T (NS).
- ( ) R15. Connect the 5  $\Omega$  5 watt resistor from lug 1 (NS) to lug 3 (S-2) of terminal strip TA.
- ( ) C18. Cut the lead on the positive (+) end of the 1000  $\mu$ fd 15 volt electrolytic capacitor to a length of 2-1/4". Put a 1-3/4" length of insulating sleeving over this lead. Cut the negative lead to 1".
- ( ) Connect the positive lead to lug 1 of terminal strip T (S-3).
- ( ) Connect the negative lead to lug 1 of terminal strip TA (S-4). Place as shown in Detail 7J.
- ( ) Connect the black wire of the twisted pair coming through grommet HH to lug 8 of switch BB (S-1).
- ( ) Connect the red wire of the twisted pair to lug 2 of switch BB (S-1).
- ( ) Strip 3/4" of insulation from one end of a 4" length of black hookup wire. Run this end through lug 9 (NS) to lug 10 (S-1) of switch BB. Now solder lug 9 (S-2).
- ( ) Strip 3/8" of insulation from the other end of this wire and connect it to lug 5 of switch BB (NS).
- ( ) Connect a length of black hookup wire from lug 5 of switch BB (S-2) to lug 1 of control CC (NS).
- ( ) Bend the control solder lug under control CC to touch lug 1 (NS).
- ( ) C15. Connect a .01  $\mu$ fd disc ceramic capacitor from lug 1 (S-3) to lug 3 (S-2) of control CC.
- ( ) R10. Connect a 6.8 K $\Omega$  (blue-gray-red) 1/2 watt resistor from lug 2 of control CC (S-1) to lug 4 of switch BB (S-1).
- ( ) Connect a length of yellow hookup wire from lug 3 of tube socket V2 (S-4) to lug 12 of switch BB (NS).
- ( ) R2. Connect a 2.2  $\Omega$  (red-red-gold) 1/2 watt resistor from lug 12 (S-2) to lug 7 (NS) of switch BB.
- ( ) R3. Connect a 390  $\Omega$  (orange-white-brown) 1/2 watt resistor from lug 6 (S-1) to lug 7 (S-3) of switch BB.

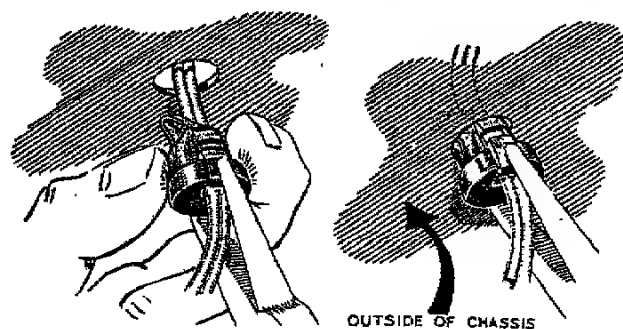


Detail 7D

- ( ) R9. Mount the 60 K $\Omega$  100 watt bleeder resistor at AH as shown in Detail 7D. Orient this resistor so that its lugs are toward the chassis. Tighten the #10 nut on the back of the chassis, then place two #10 flat washers on the stud, followed by the #10 wing nut.
- ( ) Connect a length of blue high-voltage wire from lug 1 of resistor AH (S-1) to lug 4 of tube socket V6 (S-3).
- ( ) R6, 7, and 8. Connect three 4.7  $\Omega$  (yellow-violet-gold) 1/2 watt resistors from lug 2 of resistor AH (NS) to the ground lug under the mounting foot of transformer AB (S-3).
- ( ) Connect a length of red hookup wire from lug 2 of resistor AH (S-4) to lug 3 of switch BB (S-1). Route this wire as shown, under transformer AC.

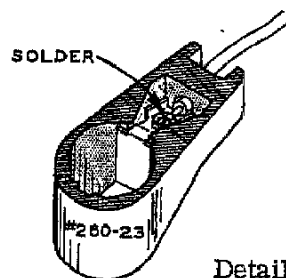
( ) Separate the wires at one end of the line cord for approximately 2". Strip and tin 1/4" of each wire.

( ) Referring to Detail 7E, mount the line cord and the strain relief in the hole near terminal strip U.



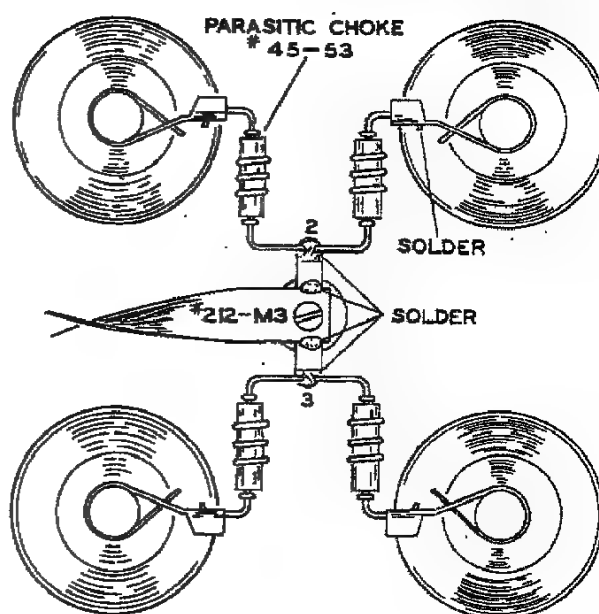
Detail 7E

- ( ) Connect one wire of the line cord to lug 4 of terminal strip U (S-5).
- ( ) Connect the other wire to lug 2 of terminal strip U (S-2).
- ( ) Run the two red leads coming from plate transformer Y up through grommet ZZ. Cut both of these red leads so that 6" protrudes above grommet ZZ.
- ( ) Strip and tin the red leads for a length of 1/4". Solder a ceramic plate cap to each red lead. Refer to Detail 8A.



Detail 8A

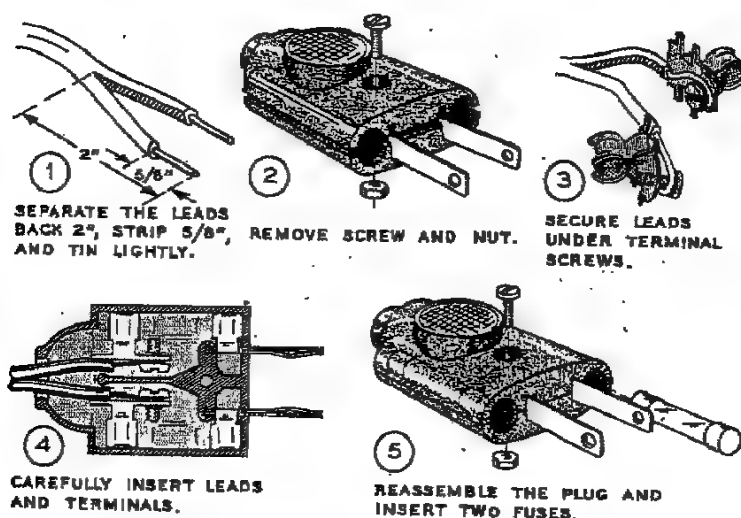
- ( ) Connect the center conductor of the free end of the RG-8/U coax cable, protruding through the hole at the end of LOADING capacitor H, to lug 5 of LOADING capacitor H (S-1). Twist the terminal slightly to aid in making this connection. Refer back to Pictorial 4.
- ( ) Solder the shield lead of the RG-8/U coax cable to terminal lug 2 of LOADING capacitor H (S-1).
- ( ) Place the four 811A tubes in their sockets, inside the RF shield. Handle these tubes with care, as damage to the filaments could result from a sharp jar to the glass envelope.
- ( ) Referring to Detail 8B, place the spring plate caps on the 811A tubes as shown. Orientation is important.
- ( ) Bend the leads of the parasitic chokes to conform with their orientation shown in Detail 8B.
- ( ) Place one lead of each parasitic choke through the hole in the proper plate cap and solder (S-1).
- ( ) Solder the other lead of each parasitic choke to lug 2 or 3 of RF choke K as shown in Detail 8B.



Detail 8B

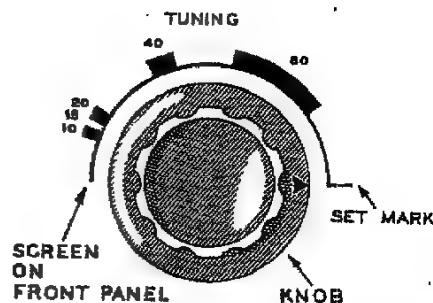
- ( ) Solder the silver plated strap to lugs 2 (S-1) and 3 (S-1) as shown in Detail 8B. Take care not to solder the screw.

Referring to Detail 8C, install the fuse plug on the end of the line cord as follows:



Detail 8C

- ( ) Open the plug to expose the screw terminals.
- ( ) Split the cord approximately 1" back from the end and separate the two wires.
- ( ) Strip the ends of the wires back 1/2" and lightly tin the bare strands. Position the cord in the "bell" of the plug, run the wires along the separate channels provided and connect the wires to the screw terminals. Use a hook in the same direction as the screw rotation.
- ( ) Reassemble the plug and install two type 3AB fuses rated not higher than 15 amperes. Four 15 ampere fuses are supplied.
- ( ) Place the 1-11/16" steel shaft extension through the bushing into the shaft coupling on the TUNING capacitor. Secure with a 6-32 x 1/4" BHMS.
- ( ) Place two 8-32 x 1/4" Allen setscrews in one of the large cast knobs.
- ( ) Fully mesh the plates of the TUNING capacitor. By running your finger under the capacitor plates, the exact position when the plates are fully meshed can be easily determined.
- ( ) Referring to Detail 8D, secure the large knob to the TUNING shaft extension with the pointer aligned to the set mark below the 80-meter marking.
- ( ) Secure a large knob to the BAND switch shaft, using two 8-32 x 1/4" Allen setscrews. Rotate the switch shaft to its full counterclockwise position and tighten the setscrews with the knob pointer at the 10-meter marking.



Detail 8D

- ( ) Rotate the LOADING capacitor shaft to the full counterclockwise position. Secure a large knob to the shaft using two 8-32 x 1/4" Allen setscrews. Orient the knob so that the pointer is at the zero position and tighten the setscrews.
- ( ) Place the small metal knobs on the METER switch shaft and RELATIVE POWER control shaft. With both the switch and control shafts in their full counterclockwise position, orient the switch knob pointer to GRID and the control knob pointer to a 7 o'clock position. Secure with 8-32 x 1/4" Allen setscrews.
- ( ) Place the small red knob on the RF Monitor level control on the rear of the chassis.
- ( ) Since there is very little wiring in the HA-10, a wiring harness was not considered practical. However, the wiring may be made to look neater if the wires along the sides of the chassis are taped or tied together at various points.

## TESTING

LETHAL VOLTAGES ARE PRESENT IN AN AMPLIFIER OF THIS SIZE. CONSEQUENTLY, GREAT CARE MUST BE EXERCISED WHEN ANY TESTS OR ADJUSTMENTS ARE MADE.

- ( ) Put both the POWER and HV switches in their OFF position.
- ( ) DO NOT install the 866A tubes in their sockets at this time.
- ( ) Temporarily jumper the two screw terminals on the rear apron marked CUT OFF BIAS. A short piece of hookup wire connected between the terminals will suffice.
- ( ) Plug the amplifier into a 117 volts AC, 60 cycle outlet. This outlet should be of modern design and fed with wire not smaller than #14.
- ( ) Turn the POWER switch ON. The filaments in the 811A tubes should light and the cooling fan should start. The green pilot light should be lit.
- ( ) Turn the POWER switch OFF. Set the amplifier on its side.
- ( ) Turn the POWER switch ON. Check the voltage between lug 3 of tube socket V2 and chassis ground. The reading should be 4.5 volts negative. Use a HEATHKIT VOM, or equivalent 20,000 ohms/volt meter, for this measurement.
- ( ) Check the voltage between the following points and the chassis: lug 3 of V1, lug 3 of V3, lug 3 of V4. In all cases the voltage should be 4.5 volts negative.
- ( ) Set the amplifier upright.
- ( ) Disconnect the amplifier from the 117 volt outlet.
- ( ) At this point, the meter scale should be studied to determine just what the meter will indicate for the various positions of the METER switch. Refer to table below.
- ( ) Place the two 866A rectifier tubes in their sockets near the plate transformer.
- ( ) Place one of the ceramic plate caps on each 866A.
- ( ) Reconnect the amplifier to the 117 volt AC outlet and turn the POWER switch ON.
- ( ) Let the rectifier tubes warm up a minimum of 30 minutes before proceeding with testing. This warm up time is needed to vaporize the mercury in these tubes. If the amplifier is moved, this warmup period should be repeated.

METER SWITCH POSITION	MEASURES	RANGE
GRID	Grid Current	0-200 ma
PLATE	Plate Current	0-1000 ma
REL. PWR.	Relative Voltage Developed In Transmission Line	Adjustable By Sensitivity Control
HV	Plate Voltage	0-2000 volts



- ( ) Set the controls on the amplifier as follows:

TUNING	80-meter marking
BAND	80-meter marking
LOADING	ZERO - full counterclockwise
METER	PLATE
RET. POWER	
SENS.	Counterclockwise
POWER	ON
HV	OFF

- ( ) Turn the high voltage switch ON. The plate current should read between 90 and 100 mils. The red pilot light should light.
- ( ) Turn the METER switch to GRID. There should be no grid current.

- ( ) Turn the METER switch to HV. There should be a reading of about 1800 V DC. This will vary slightly, depending on the variations in the 117 volt line.

- ( ) Turn the HV switch OFF.

- ( ) Turn the power switch OFF and disconnect the 117 volt source.

- ( ) Secure the RF shield cover in place, using #6 sheet metal screws.

- ( ) Remove the temporary jumper that is across the cut off bias terminals.

This completes testing.

## CABINET INSTALLATION

- ( ) Install the four large rubber feet in the cabinet. Use #8-32 x 3/8" hardware, inserting a screw through each rubber foot, and then through the cabinet bottom. Use #8 lockwashers under the nuts. Tighten securely.
- ( ) Place the amplifier in front of the cabinet and pass the line cord through the opening

in the back of the cabinet. Now slide the amplifier onto the rails and into the cabinet while guiding the line cord through the opening in the back. Use ten #10-32 Phillips head screws to fasten the front panel to the cabinet. Use eight #10 sheet metal screws through the back of the cabinet, into the rear chassis apron.

## INSTALLATION

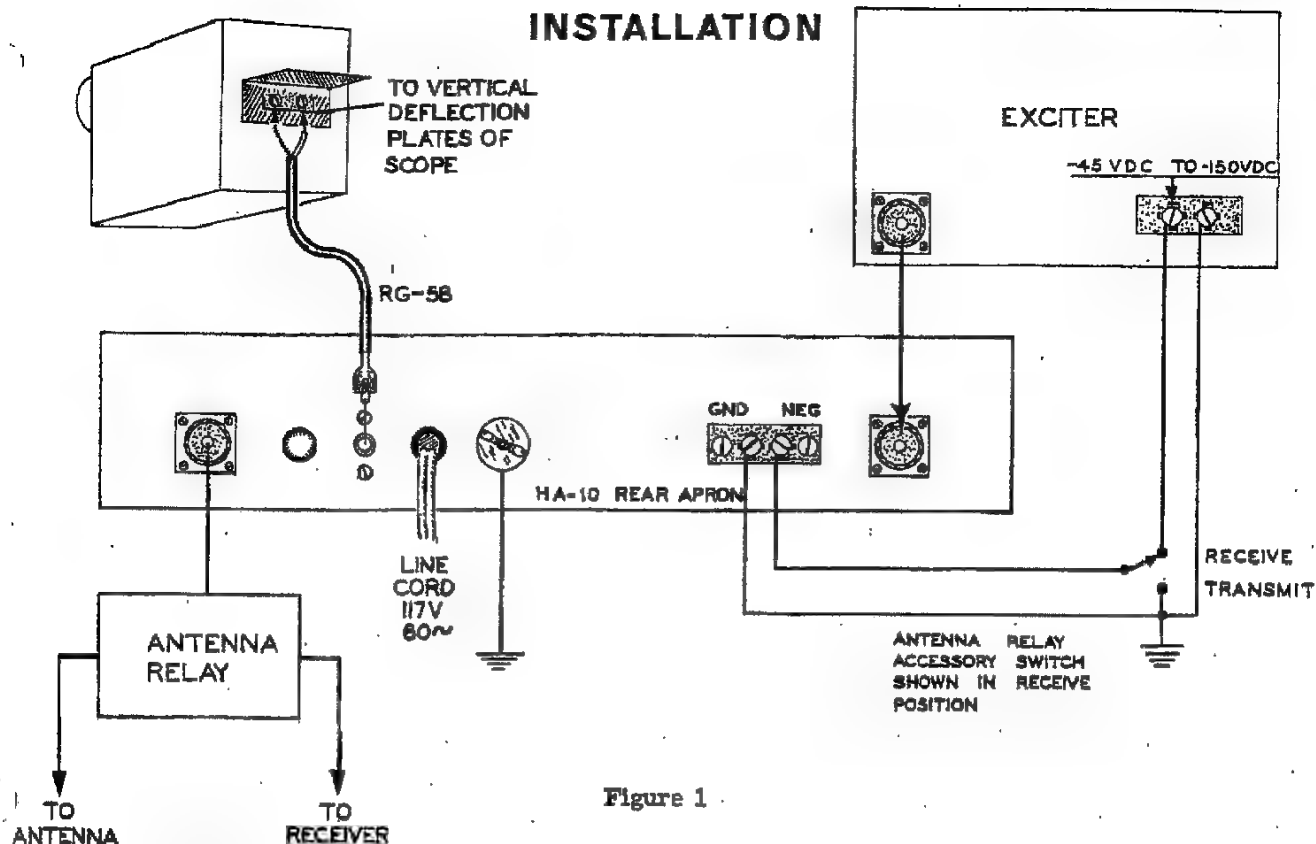


Figure 1

Refer to Figure 1 for clarification of the following information.

## LOCATION

Although the amplifier has a built-in fan for cooling purposes, avoid excessively warm locations such as those near radiators and heating vents. The amplifier should be placed in a location that provides adequate space around it, permitting free air circulation through the cabinet openings.

## POWER SOURCE

The amplifier is designed to operate on 117 volt, 60 cycle AC power. The peak power consumption is about 1250 watts. Special attention should be given to the source of power. The AC power outlet should be properly fused and fed with not smaller than #14 wire.

## CUT-OFF BIAS

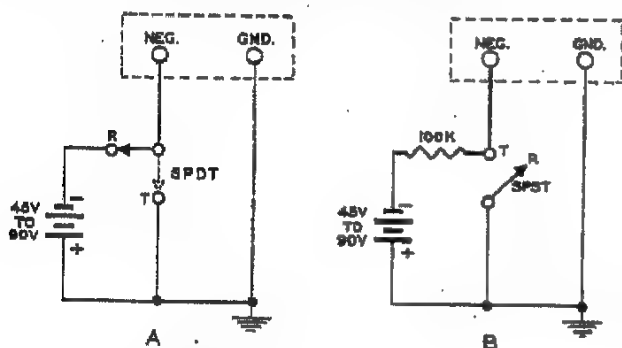
To avoid standby tube noise and possible instability when the antenna is disconnected from the amplifier, the 811A tubes should be cut off by applying bias during receive and standby periods. This will also reduce heat and power consumption.

A negative voltage of between 45 and 150 volts is applied to the NEG. terminal of the bias terminal strip during receive periods. The NEG. terminal must be grounded during transmit periods. Some exciters provide this cut-off bias with the proper switching built-in; others will require using a set of switch contacts on the antenna relay to perform the proper switching action.

When using this amplifier with the SB-10 and TX-1 or DX-100B, the NEG terminal of the bias terminal strip can be connected directly to pin 5 of the octal socket on the rear apron of the SB-10 without going through an antenna relay accessory switch, as the proper switching is performed in the SB-10.

When the 811A tubes are completely cut off by applied bias, the meter should still indicate about 30 ma plate current. This current is the current in the bleeder resistor and is not actual plate current.

If bias is not available from the exciter, a radio B-battery may be used. The negative terminal of the battery should be connected to the amplifier through antenna relay accessory switch contacts just as if bias were being furnished by the exciter. Either of the two following circuits can be used, depending on whether SPST or SPDT switch contacts are available.



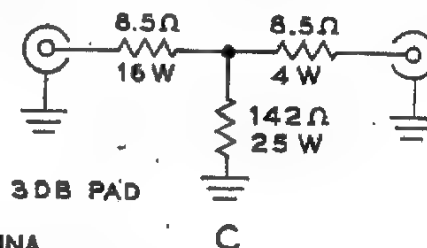
### SCOPE MONITORING

The amplifier has a built-in capacitance divider for ease in monitoring. Connect approximately four feet of RG-58 coax cable between the MONITOR pin jack and the vertical deflection plate terminals of the scope.

The capacitance of the coax together with the variable mica compression capacitor form the divider. By increasing the capacitance (clockwise rotation) of the compression capacitor, the monitoring level is increased. Different lengths and types of coax feeding the scope will vary the monitoring level. Greater lengths of coax will decrease the level.

### EXCITER

This amplifier can be driven by most any commercial or home-built exciter, including 50  $\Omega$  fixed output impedance types, having a power output of between 50 and 100 watts, without the use of swamping pads or matching units. Exciters in the 40 to 50 watt output class will not drive the HA-10 to a full kilowatt on the higher frequency bands, but the amplifier will operate quite efficiently at the slightly lower power level obtained. Exciters having power outputs of more than 100 watts can be used by connecting a swamping pad between the exciter and linear. Such a pad is shown below. The resistors can be made from combinations of common 2 watt carbon resistors.



### ANTENNA

The pi-network output is designed to work into a 50 to 75 ohm transmission line. Most commercial and home-built antennas are designed to be fed with 50 or 72 ohms coax, RG-8/U or RG-11/U coaxial cable is recommended for the transmission line and every effort should be made to get the SWR of the antenna down to less than 2 to 1.

## OPERATION

### SSB

Set the front panel controls to their proper positions as outlined below:

METER Switch .....	PLATE
REL. PWR. SENS. Control .....	FULL CLOCKWISE
TUNING .....	Desired Band Segment
BAND Switch .....	Desired Band
LOADING .....	Full Counterclockwise
POWER Switch .....	ON
High Voltage Switch .....	OFF

1. After allowing the 866A rectifiers to warm up for about one minute, turn the High Voltage switch ON.

**CAUTION:** Never apply drive without the high voltage being ON, as excessive grid current will result.

2. Insert carrier into the exciter and load it into the amplifier until the plate current rises from the indicated 100 mills to about 200 mills.
3. Turn the METER switch to REL. PWR. and tune the TUNING control for maximum meter reading. If necessary, decrease the REL. PWR. sensitivity to keep the needle on the meter scale.
4. Increase the drive from your exciter and load the amplifier for maximum relative power output by turning the LOADING control slightly clockwise and retuning the TUNING control for maximum meter reading. The REL. PWR. SENS. control will probably have to be further reduced to keep the needle on the meter scale.

5. When maximum output is obtained, turn the METER to PLATE and then to GRID for proper loading check.

The following readings should be indicated for operation with maximum power input.

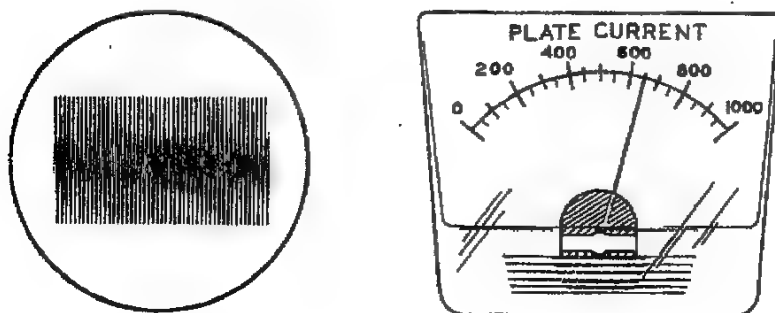
PLATE.....660 ma  
GRID.....100 to 140 ma

If the grid current is too high, reduce drive from exciter.

If the plate current is too high, reduce the LOADING control setting. For proper operation, the LOADING control setting should fall between 0 and 3 when operated into a 50  $\Omega$  transmission line with less than 2 to 1 SWR.

6. The amplifier is now loaded for operation at maximum input power. If an oscilloscope is being used for monitoring, a display similar to that shown in Figure 2 should be obtained.

The amplifier is designed for operation on an intermittent duty cycle. DO NOT allow the amplifier to operate at this high current



Oscilloscope pattern and meter reading resulting from carrier or "single tone" modulation. The meter indicates maximum or P.E.P. power input.

Figure 2

level (660 ma) for unnecessary lengths of time. If possible, limit your tune up time to 30 seconds or less, since the plate dissipation of the 811A tubes is exceeded at this high current level.

Turn the exciter to standby to remove drive from the amplifier.

7. The amplifier is now ready for SSB transmission. A typical example of a proper oscilloscope pattern is shown in Figure 3. Note that there are sharp distinct peaks. The number of patterns or "christmas trees" will depend on the individual voice and the

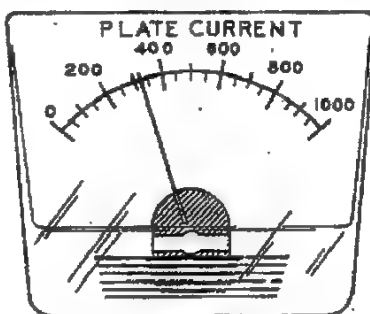


Figure 3

Oscilloscope pattern and meter reading resulting from voice modulation. Notice the peaks on the oscilloscope pattern. They are sharp, indicating a clean signal, and they attain the same height as the "single tone" pattern of Figure 2, indicating maximum power input. NOTE: Plate current peak reading is approximately 1/2 or less of maximum "single tone" reading due to meter inertia and voice characteristics.

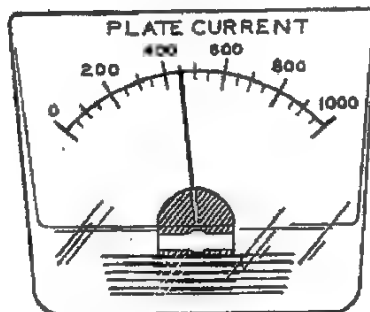
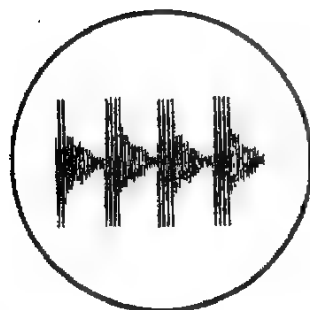


Figure 4

Oscilloscope pattern and meter reading resulting from over modulation. The meter reads higher, but the scope indicates peak flattening. Operation in this manner causes distortion and severe interference to adjacent frequencies.

## CW

1. Follow steps 1 through 6 for SSB operation. Use the same precautions against unnecessarily long tune-up time.
2. The amplifier is now loaded for CW operation at maximum input power. **DO NOT** keep the amplifier key down (660 ma) for extended lengths of time.

## AM

1. Follow steps 1 through 6 for SSB operation, except load only to 530 ma plate current (660 ma if using controlled carrier modulation).
2. Reduce the drive (carrier level from exciter) until the amplifier plate current drops to 265 ma. NOTE: The plate current is one-half the current drawn if full carrier is inserted, but is the maximum carrier level that a linear can handle and provide 100% modulation capabilities.

scope sweep speed. Set the scope for about a 30 cycle sweep. Note that the meter reading on voice peaks will not be high. The meter will indicate only one-half or less of the single tone level (660 ma), depending on the individual's voice, before "flat topping" occurs.

8. Figure 4 shows the same voice pattern but with extreme "flat topping." The oscilloscope shows that no more useful power is being developed. The meter reads higher, but only distortion is developed.

## 6DB PAD FOR AM

Figure 5 shows the circuit of a 6DB pad, for use between the exciter and the amplifier, that would be of value if your exciter does not have a power output level control, and if extended AM operation is desired. The amplifier should be loaded with the switch in CW, SSB and then turned to AM before proceeding with modulation.

This pad is necessary when using the HA-10 to amplify AM signals from exciters such as the DX-40, DX-60, or other exciters of similar power rating. The HA-10 should not be used to amplify AM signals from transmitters having output power in excess of 100 watts, as a worthwhile increase in power will not be realized.

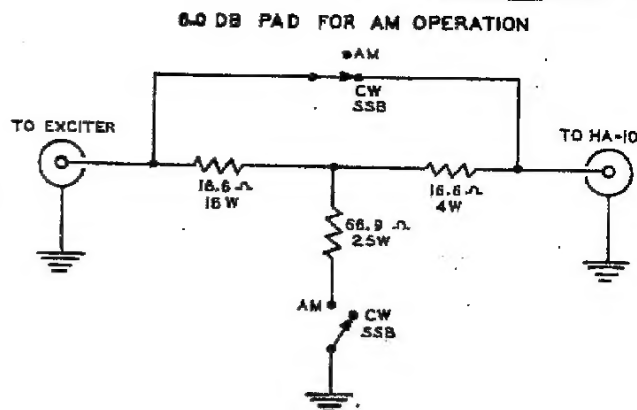


Figure 5

## RTTY

1. Follow steps 1 through 6 for SSB operation except load only to 430 ma plate current.

## BIBLIOGRAPHY

SINGLE SIDEBAND BULLETIN #9, Eitel-McCullough, Inc., San Bruno, California.

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SINGLE SIDEBAND, American Radio Relay League, Inc.

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CQ MAGAZINE, Cowan Publishing Corp., 67 West 44th St., New York 36, New York.

SIDEBAND HANDBOOK, Cowan Publishing Corp., 300 West 43rd St., New York 36, New York.

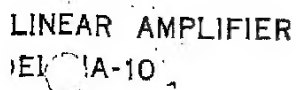
## IN CASE OF DIFFICULTY

1. Recheck the wiring. Trace each lead in colored pencil on the Pictorial as it is checked. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something consistently overlooked by the constructor.
2. It is interesting to note that about 90% of the kits that are returned for repair, do not function properly due to poor connections and soldering. Therefore, many troubles can be eliminated by reheating all connections to make sure that they are soldered as described in the Proper Soldering Techniques section of this manual.
3. Check to be sure that all tubes are in their proper locations. Make sure that all tubes light up properly.
4. Check the tubes with a tube tester or by substitution of tubes of the same types and known to be good.
5. Check the values of the component parts. Be sure that the proper part has been wired into the circuit, as shown in the pictorial diagrams and as called out in the wiring instructions.
6. Check for bits of solder, wire ends or other foreign matter which may be lodged in the wiring beneath the chassis.
7. A review of the Circuit Description will prove helpful in indicating where to look for trouble.

# TROUBLESHOOTING CHART

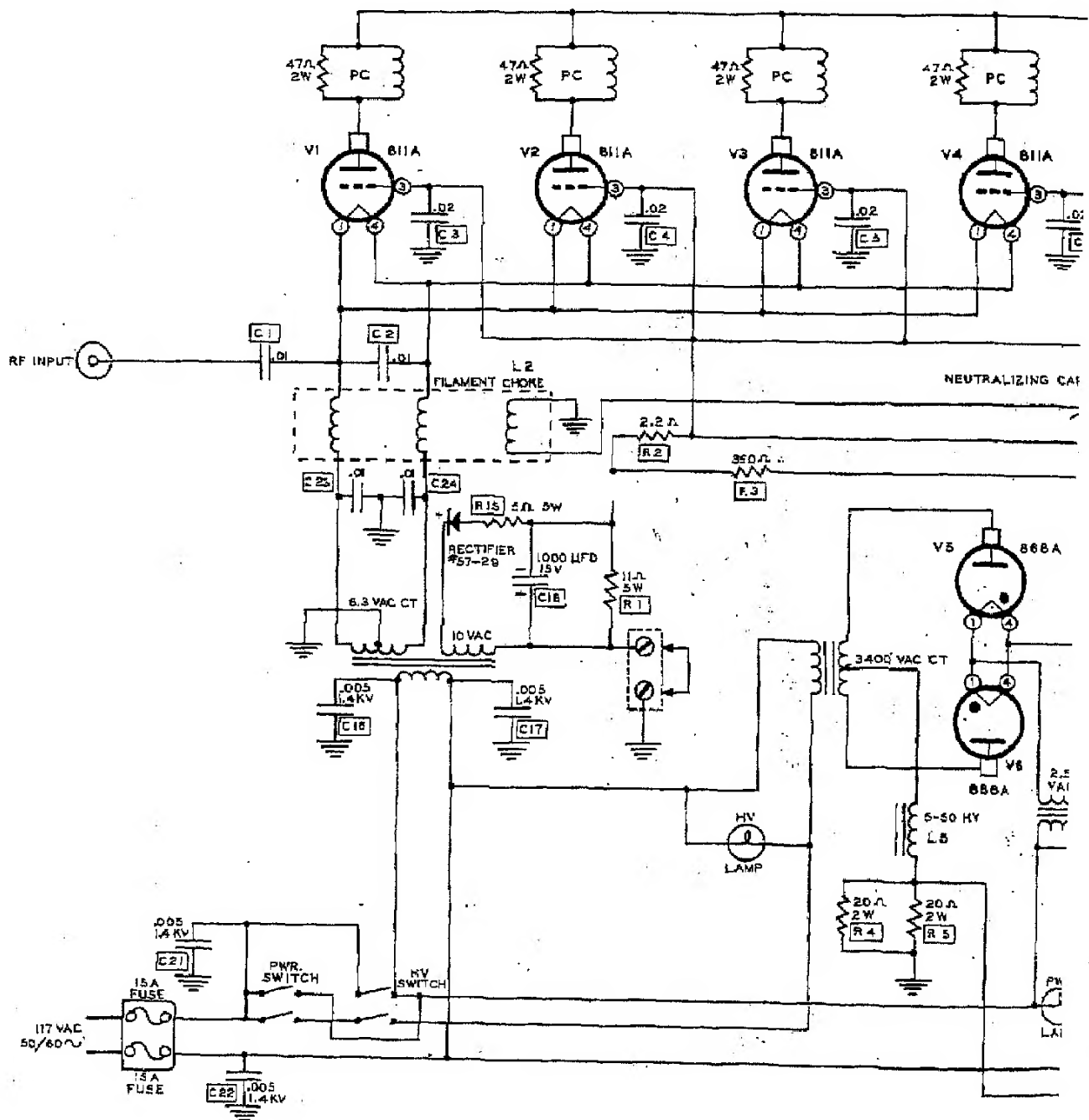
NOTE: Use caution on all tests. Work with power OFF if at all possible. Measurements were made with a HEATHKIT VOM (20,000 ohm/volt).

DIFFICULTY	POSSIBLE CAUSE
No power.	<ol style="list-style-type: none"> <li>1. Check complete 117 V AC wiring against schematic and pictorials.</li> <li>2. Blown fuse - check fuse continuity.</li> </ol>
No fan operation.	<ol style="list-style-type: none"> <li>1. Check for errors in wiring of fan leads.</li> </ol>
No bias on pin 3 of all 811A tubes.	<ol style="list-style-type: none"> <li>1. Check for shorted electrolytic capacitor.</li> <li>2. Check for 10 V AC between terminal KK2 and chassis, with cut-off bias terminals jumpered on rear apron.</li> <li>3. Check for faulty bias rectifier.</li> </ol>
Improper resting plate current (not 90 to 100 ma).	<ol style="list-style-type: none"> <li>1. Cut-off bias terminal on rear apron not jumpered, or grounded.</li> <li>2. Improperly neutralized.</li> <li>3. Check for open or damaged parasitic choke in 811A plate leads.</li> <li>4. Check to make sure the .02 <math>\mu</math>f disc capacitors from pin 3 of the 811A tubes are properly grounded.</li> <li>5. No bias on pin 3 of 811A tubes.</li> </ol>
Unable to tune tank circuit to resonance.	<ol style="list-style-type: none"> <li>1. Check 10 meter coil connector to tuning capacitor.</li> <li>2. Check BAND switch and multiband coil for wiring error.</li> </ol>
No high voltage.	<ol style="list-style-type: none"> <li>1. Check for 117 V AC wiring error.</li> <li>2. Check for improper wiring of POWER and HIGH VOLTAGE switches.</li> </ol>
Blows fuse when HIGH VOLTAGE switch is thrown ON.	<ol style="list-style-type: none"> <li>1. Check for shorted filter capacitor or bleeder resistor. USE CAUTION, be sure filter capacitor is discharged and power cord removed from outlet before making any tests.</li> <li>2. Allow 866A tubes to warm up thoroughly for complete vaporization of mercury. (At least 30 minutes.)</li> <li>3. Faulty 866A tube.</li> </ol>
Filaments of 811A do not light.	<ol style="list-style-type: none"> <li>1. Wiring error - check for 6.3 V AC between pins 1 and 4 on 811A tubes.</li> <li>2. Faulty 811A tube.</li> </ol>



CAPACITORS ARE IN  $\mu$ F EXCEPT WHERE NOTED.





KILOWATT L  
MODE